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Engineering News-Record

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What Is the Trend of Highway Development?

THE past year has been one of unusual confusion in the highway field. Materials shortage—due to transportation difficulties—has affected many highway programs and has turned thought in new directions. At the same time it has prevented us from discovering and appreciating the trend of development.

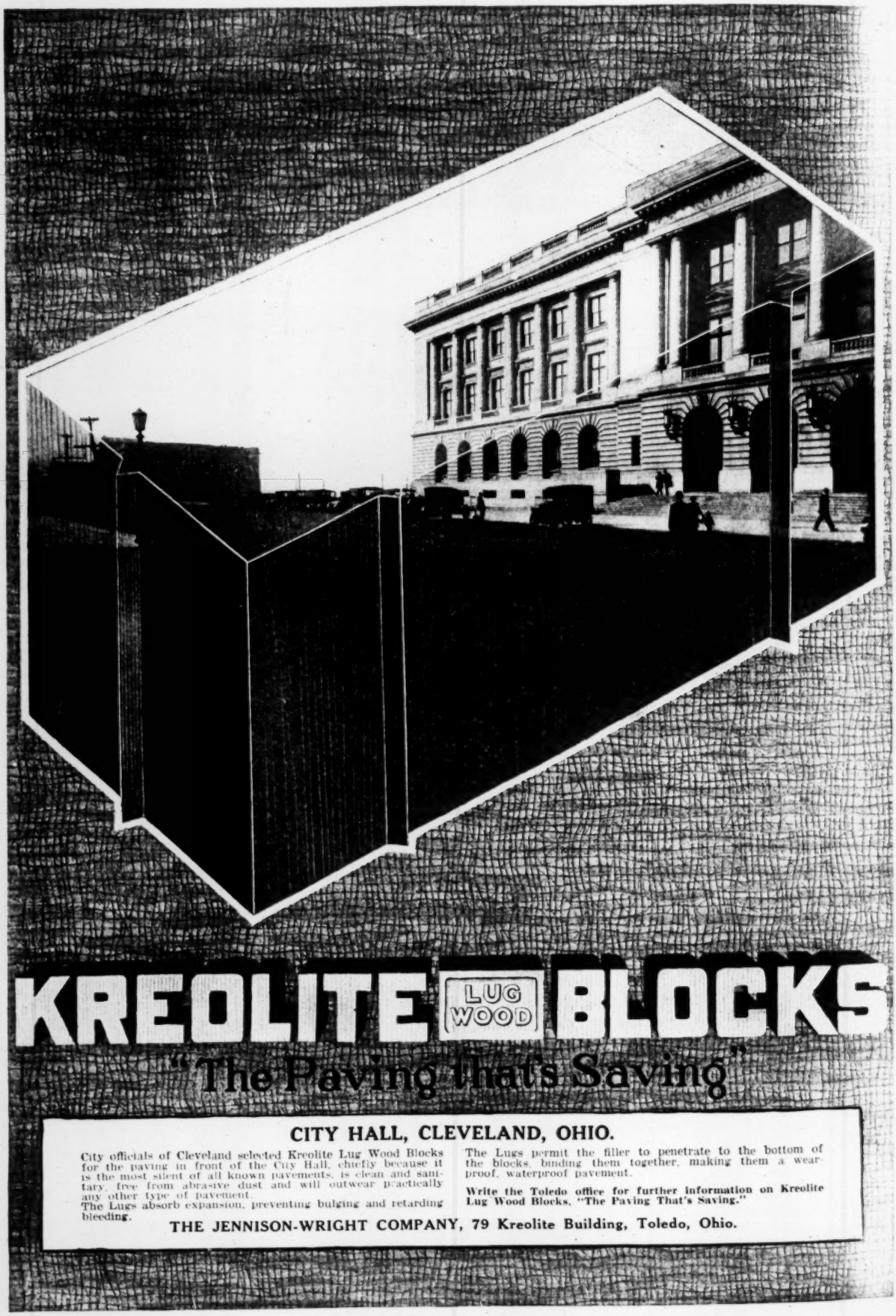
To learn the exact status of highway thought, *Engineering News-Record* is having three of its editors make a survey of the highway field. C. S. Hill, associate editor at Chicago, is covering the great road-building states of the Middle West—Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, Ohio, Kansas, Nebraska, Missouri and Arkansas. John W. Shaver, of the editorial staff at New York, will visit some of the Eastern States—Maine, Massachusetts, Rhode Island, Connecticut, Pennsylvania and Delaware, while N. A. Bowers, Pacific Coast editor, will tell the direction of highway development in California.

In this way our readers will get the views of the states that are driving hardest in new work—those of the Middle West; they will learn the attitude and problems of the maturer organizations of the New England States, and get a glimpse, through a California review, of the thinking, always original and courageous, of the Pacific Coast.

THESE STATES, it is true, do not constitute the whole country. We wish that we might cover every state, but even the survey now in progress has involved an immense amount of time and travel. Something might be done by correspondence, but the richness of interpretation, resulting from accumulation of views through personal contact, would be lost.

The first fruits of the survey appear in this issue under the title, "The Trend of Highway Development." Other articles will follow weekly. In addition, there will come, in time, from the states surveyed special articles on outstanding features that deserve such treatment.

The series and the additional articles will present such a picture of American highway trend as has never before been attempted.



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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Flood Tide Again

RESULTS of city and state bond elections, Nov. 2, are most encouraging. Returns so far received (see the news pages of this issue), indicate a flood tide of votes for public improvements. This striking contrast with the bond election results for several years past seems to reflect a wide and deep change in the mental attitude of the mass of the people. Our own interpretation is that while accumulated deficits in needed construction work are largely responsible for the favorable votes on scores of millions of dollars in bond issues the country over, the main cause for the change is rapidly reviving confidence in the fundamental soundness of American industry today. This newly awakened faith in the future is an encouragement and an inspiration.

Victory of a New Idea

QUITE distinct from all other votes of money for public works at last week's election, the New Jersey referendum on a bond issue for interstate tunnel and bridge construction represents the victory of a new conception—new in the consciousness of the voting public. That conception is one which we have set forth time and again in these columns: the inherent unity of adjoining states and their highway systems, now cut apart at nearly every frontier. Few states are so thoroughly isolated as New Jersey, bounded by water on east, south and west, and having only primitive facilities for crossing its bordering rivers, the Hudson and the Delaware. Doubtless this is the reason why the proposal to issue bonds for building a bridge over the Delaware at Philadelphia and a tunnel under the Hudson at New York carried by a large majority, in the face of other heavy demands on the state's resources. New Jersey people have learned—at last—that a highway network within the state alone is only half a loaf, and that unless they provide for as free communication across the borders of the state as within the state the interests of its own people will be strangled. This is a new truth so far as popular recognition is concerned, and willingness to spend money for its realization is a new spirit among taxpayers. But we may predict, quite safely, that in a very few years indeed this truth will hold sway from ocean to ocean

Federation Decisively Defeated

THE result of the American Society of Civil Engineers' referendum on joining the Federated American Societies has been announced: The federation proposal has been defeated, by a large margin. Not only does the negative plurality reach almost one thousand votes in a record total of 5,608 but every quarter of the country contributes to the total (see news section). Only the Pennsylvania-Ohio region, the north central states and the far southwest cast an affirmative majority. The verdict is decisive. No doubts as to the society's attitude can remain such as were left after the close vote on the development committee questionnaire last spring. Whatever one's individual wish may have been, all, we feel sure, will concede that the outcome of the referendum is clear-cut. It marks the end of the debates and contests that have agitated the society for the past year or two, and clears the way for united effort on other matters.

A Bold Irrigation Project

FOR a single state to conceive and make extensive studies and estimates for an irrigation project designed to serve 1,753,000 acres with 20,000-sec.-ft. of water at an outlay of $300,000,000 is unprecedented. That is what has been done by the Columbia Basin Survey Commission with a state appropriation of $100,000. In fact, the project is unprecedented as a whole as also are some of its elements compared with irrigation works heretofore executed, while in point of cost and general magnitude it is second to but few public works projects either carried out or planned. The main features of the project are given on p. 944. The daily capacity of the main canal and other trunk-line conduits is 1,728,000,000 cu.ft., or 12,725,000,000 gal., which is 25 times the carrying capacity of the Catskill aqueduct. The state of Washington deserves great credit for its courage in undertaking such a study.

Labor Recruiting

DISCUSSIONS are under way in Philadelphia between the building-trades council and the Industrial Relations Committee of the Chamber of Commerce, looking toward co-operation of employers and employees in the bettering of building conditions in the city (a situation, by the way, quite at variance with the unsavory condition being disclosed at New York). There is now no organization of building-trade employers at Philadelphia. In urging such an organization, in order that there may be a representative body to deal with, the unions urge, among other points, one that deserves strong emphasis, namely, that the employers should share with the employees the responsibility of bringing desirable young men into the building trade, and, that having assisted in their induction, the employees should help in the systematic training of the men. The idea is a thoroughly sound one, even if it could have no other effect than to provide a continuous supply of competent workers. But the scheme would have a very wide influence. Entered into sincerely by the employers, they could not, if they had one speck of humanity, fail to see that conditions had to be such as would allow them, in conscience, to invite men into the trades. It may sound foolishly altruistic to talk about conscience in the relationships of a trade where strife has seemed to dull all but combative instincts, but we do not believe that it is so. There would be those who would hold back, but,

if the plan be successful, it would be because broad-visioned men were supporting it—and they could be relied upon to bring the recalcitrants to task. The proposed responsibility, once accepted, would cause a broad study to be made of every phase of the labor problem by every participating employer. In this he would be helped by the necessary studies of the group officials or representatives. Altogether the idea is pregnant of much good. It is still in the early-discussion stage, and is involved with other—and very touchy—questions. Nothing may come of it at Philadelphia, but it is well worth passing on to other localities.

Moving Platforms

IN THE REPORT on the comprehensive rapid transit plan for New York City during the next twenty-five years, outlined in this journal, Oct. 14, p. 754, Mr. Turner's advocacy of moving platforms east and west, across Manhattan Island, again brings up a subject which has received considerable study by the Transit Construction Commission. Except for the execrable subway shuttle "service" between Times Square and Grand Central Station, involving excessively long walks at either end, there is no means of traveling across town except on surface cars. On them the trip is constantly becoming more slow and unsatisfactory, due to the long delays at the crossing of the very busy north-and-south thoroughfares. In the underground moving platforms is seen a satisfactory solution of the cross-town traffic problem. Mr. Turner summarized their advantages over shuttle trains in a report rendered a year ago, as follows: The elimination of long walks at transfer points, of one waiting period, and of platform congestion; a saving in time in making transfers, and vastly increased capacity, insuring seats for all passengers. Regarding capacity, it is estimated that a three-speed platform across 42nd St., running at 3, 6 and 9 miles per hour, could handle 31,680 passengers per hour in each direction, whereas the maximum of the present shuttle seldom exceeds 9,000 per hour. It is also believed that moving platforms across 14th, 34th or 42nd Sts., could be operated at a profit, even assuming the establishment of transfer privileges between them and the north and south trunk lines, for they would not only invite passengers to these lines, but would receive the large and lucrative short-haul business of the shopping districts. Obviously, it is to be expected that the first platform built will not display the degree of perfection that will obtain in later constructions, but the evidence in hand is convincing as to the feasibility and effectiveness of the system.

Writing Engineering Reports

A READING of Mr. Mead's article, "Hints on the Writing of Engineering Reports," Nov. 4, p. 891, and a discussion of the subject on p. 947 this week by five prominent consulting engineers, should focus attention upon a subject of primary importance in professional work. In recent years the engineering schools have given evidence of a growing appreciation of the value to an engineer of the ability to write and speak clearly, while among men in professional practice the ranks of those who are always "too busy to write" are being slowly but surely depleted. Much educational work, however, still remains to be done. In both the article and the discussion there is striking unanamity of opinion on one feature of report writing: Engineers should present their story in language which the non-technical reader can understand. They generally either fail to place themselves in the position of those who are expected to read what they write or else lack the necessary literary skill to accomplish the result desired. When a project is in its development stage it is of first importance that the bankers should have a clear-cut presentation of the main issues. If the engineer fails to state his case effectively, funds will not be forthcoming. Much depends upon the point of view of the writer of a report. If he considers his task merely as the accumulation of data to be buried in dusty files he might better leave his work undone. If he undertakes the preparation of his report with the conception that it is to be the means of aiding others to make a decision or to acquire information by giving them a vivid mental picture of the situation, he will be on the right road toward producing something worth while. Emphasis can be well placed, also, on a point discusesd by Colonel Wilgus—the perfection of the mechanical features of a report. There is no question as to the soundness of his advice regarding type display, illustrations and other details too frequently ignored. In the case of public works reports engineers may be justly criticized for the long delays in publication. It is common for this journal to receive printed reports of city, state and government departments several *years* after the date on which they are submitted. In such cases lack of timeliness renders them practically worthless. The report is a valuable tool to those who appreciate its uses. A realization of its possibilities is something by which engineers should profit.

The Trend of Highway Development

STATE highway departments and lesser roadbuilding organizations which, during the season now closing, have been confronted by a multiplicity of construction difficulties, and whose 1921 programs are consequently yet unformed, should find material aid in the series of articles upon the trend of highway development beginning in this issue.

Each highway department naturally has its own problems. All, during the past year, have suffered more or less from the same fundamental difficulties. Yet perhaps not in any two states have those difficulties been accentuated to the same degree. *Engineering News-Record*, through this series of staff articles that will reveal individual as well as sectional problems, becomes the clearing house for expositions of the manner in which states of the Middle West, Far West and Atlantic seaboard have surmounted these barriers to ease in highway construction, maintenance and administration.

From among the great roadbuilding organizations of the Middle West, which are just entering their era of greatest highway development, will come articles on how best to expend available moneys for building the foundation of extensive and durable systems. They give newer highway organizations the essentials of successful administration of more or less limited funds. California, upon whom all highway attention is now focussed because of her experiences with a variety of so-called durable types subjected to heavy and intensive vehicular traffic, should offer wise counsel. Eastern states, whose highway departments, in general, have been functioning for more than a decade and whose

systems are definite and well advanced in hardsurfacing should clarify questions concerning the finer points of highway construction, maintenance and administration.

So, whether the reader of these articles has been distressed by any of the general highway problems encountered within the past year or whether special problems in design or economics are sought, this series should prove of benefit.

Efficient River Control for Irrigation

SHOT-GUN control of irrigation headgates by the individual owner has long since gone out of date. In most of the irrigated areas it is the function of the state to provide the machinery for an equitable distribution in accordance with priority rights or decrees as determined by court decisions. The engineer plays no small part in this machinery, particularly when the appropriations approach or exceed the available supply, for upon his shoulders falls the responsibility of determining daily the aggregate of individual needs and then meeting this with just enough natural flow plus storage water, since any waste by the lowest gate is of course irretrievably lost. When natural flow and stored water belong to different rights, as they usually do, the problem becomes complicated, and acutely so, from the human interest standpoint, when storage water must be transmitted for 300 miles past half a hundred yawning headgates, owners of which are entitled to natural flow only. That was the situation on the Snake River basin noted on page 927 during the season of 1919, the driest year of record.

As to the success of the described single-headed plan of operation, the records indicate that almost a complete utilization of Snake River water was effected in 1919. At the Milner dam, the lowest point on the river from which gravity diversions for irrigation are possible on any large scale, the flow from June 5 to Sept. 30 was limited to leakage past the dam, ranging from 13 to 50 sec.-ft., depending on the head maintained and averaging 26.6 sec.ft. This quantity indicates the wastage from the entire upper river and to some extent is a measure of the efficiency of the distribution. To a representative of *Engineering News-Record* who inspected the Milner dam in August, the quantity appeared small indeed. The famous Twin Falls 25 miles below the dam presented a most dismal naked appearance.

Practically the same methods were used in 1920 but the distribution was even more difficult and required more care since Lake Walcott was eliminated as a catch basin and reservoir, due to the desire of the Reclamation Service to maintain the lake at its maximum for the purpose of developing the needed amount of power at the Minidoka dam. During the entire period from July 9 to Sept. 20, when regulation was necessary, water was wasted through the Milner dam in excess of the unavoidable leakage *on parts of two days only*.

Special attention is directed to the centralized control which the water users brought about by arranging for a combination of the stream measurement work of the U. S. Geological Survey and the distribution functions of the State. The method has distinct advantages to the valley as a whole and may well be studied by those in charge of water distribution in other states.

Shelf-Hardware Filter Details Far Off

FILTER details of the shelf-hardware type have not yet been developed, so one will conclude, after reading the filter-problem symposium on p. 934. Many things work well but with nowhere near 100 per cent efficiency and it is distinctly the province and duty of the designer to make each new design better, profiting from the experience gained in the operation of previous designs. It has been said that the discovery of an inexpensive method of disinfection has put off by at least twenty years the construction of many hundreds of filter plants and it might also be added that it has also thereby retarded the development to a more nearly perfect state those parts of a filter which have to do directly with the filtering medium. Experimental plants have been all too few in the last ten years. All of the things necessary to a filter plant have not been discovered, and while much can be learned from actual operation there is usually not sufficient flexibility to obtain limits of various factors.

Proper sand size and the most effective depths have long been well established and fairly well agred to, but there is no unanimity of opinion on most of the surrounding mechanism. That some kind of a supporting gravel layer is necessary is agreed to but the depth used varies from 6 to 18 in., with the preponderance of opinion in favor of the greater depths. Methods of admitting the water to the filter are as varied almost as the number of designers. Definite principles on which to base the design seem still to require much careful consideration and much experimentation. Elaborate tests have been made at Sacramento on the size and spacing of perforated-pipe laterals and openings in these laterals under varying conditions of water inflow. However, only one depth of gravel bed, 18 in., was used. Someone ought to experiment with a range of gravel depths so as to define the limits as well as to learn the best size of the different layers to use. The symposium indicates that many combinations work but there must be some depth beyond which it is unnecessary to go for efficient distribution and below which difficulties arise.

The mud-ball situation seems to require quite an extensive country-wide series of experiments to learn what character of turbidity is prejudicial to their formation. Although Mr. Ellms has operated the Cincinnati plant, which is supplied by the turbid Ohio River water, he has had no experience with mud balls, while a little farther down the river, at Louisville, a variety of difficulties are recounted by Mr. Lovejoy. Here is a fertile field for a physico-chemical investigation similar to that undertaken by Messrs. Wolman and Powell on the under-water shrinkage of sand beds (*Engineering News-Record*, July 29, 1920, p. 210; discussion, Sept. 2, 1920, p. 438), since it is more than likely colloids are a decisive factor. When the extent of the distribution of colloidal turbidities is established gutter spacing will become a more scientific procedure, as will also the necessity for the use of an air-wash.

Even with these few examples of undetermined factors in filtration practice in mind one hesitates measurably to predict an early decline in the necessity for expert service in determining local conditions and filter designs to meet them. In fact, there is no reason to suppose that such service will not always be a profitable investment.

Trend of Highway Development—A Survey

Practice in Wisconsin and Michigan

THIS IS THE FIRST *of a series of staff articles on the highway situation. It relates to practice in Wisconsin and Michigan. The outstanding features of Wisconsin's practice are the use of one-season contracts, construction by force account, utilization of local materials and the extent of maintenance work. Michigan's practice is notable for the use of gravel for trunkline construction, the conservative character of the hard-surfacing program and the intensive service secured from surplus war materials.*

The second article will appear in the next issue.—EDITOR.

WISCONSIN leads the Mississippi Valley states in mileage of force-account concrete road construction and incidentally in the development and equipment of local gravel pits for supplying aggregate for concrete roads. This position in force-account operations is the result of a definite policy of the State highway department (1) to determine costs and prices for estimating purposes and for appraising the reasonableness of bidding prices and (2) to be prepared with experience and equipment to undertake construction whenever contract and material prices appear excessive or contractors do not seek the work. Contract construction of roads will not be discouraged; it will, on the contrary, be employed as far as possible, *but not regardless of costs.*

Local pit development has made good progress. Its purpose is (1) to demonstrate the possibility of economically utilizing roadside gravel deposits and (2) to determine the practicability of attaining independence of commercial producers and of congested transportation agencies. Commercial materials will not be discarded; they will be employed generally, *but not regardless of price and slow deliveries.*

Wisconsin's great wealth of gravel beds gives the state an enviable opportunity for developing roadside material supplies. Gravel is abundant almost everywhere in the state and it is universally of excellent quality There are 7,500 miles in the state's highway system. Of this mileage approximately three-fifths are earth roads; one-fifth, gravel roads and the remainder, macadam and miscellaneous types and concrete, the ratio of concrete to the other types being about as three to seven. Extension of gravel surfacing on the earth-road mileage makes the first demand for multiplication of local supplies, but the more exacting demand comes from the planned extension of concrete roads. The 1920 development of gravel supplies has been in connection with concrete paving and, therefore, has required comprehensive pit plants.

Construction Policies—Highway contracting policies in Wisconsin express definitely the purpose of keeping costs and values, in their broad sense, always a deciding factor. It is not the policy generally to contract for more mileage in any season than can be constructed in that season. This policy applies to individual contracts as well as to the construction program as a whole. Hold-over contracts are shunned. The shortage of materials in 1920 will compel infraction of this rule in some instances, but on the whole the projects under way will be finished before cold weather. Short-term contracts, it is believed, reduce the risk due to unsettled wages and prices and uncertain transportation conditions, and the reduction is reflected in closer bidding prices.

As a further step toward this objective of closer and more safe bidding, active studies are being carried on with local contractors' organizations in stabilizing cost estimates. Out of this work are coming standard estimate forms and depreciation charges, as described in *Engineering News-Record*, April 1, 1920, p. 663. Finality in a study of this character is not easy to attain, but as the work has proceeded it has brought appreciable results in uniformity of bidding practice, and, what is perhaps quite as important, a heightened cordiality between state highway engineers and the contracting industry.

Labor Employment

A second established contracting policy is not to undertake work in such volume in any locality that its performance will disturb the labor market. As formally announced early in the season: "No work will be done or no prices will be paid for contract work which will unduly inflate the wages of men and teams and thus upset the labor standards existing in any neighborhood." In brief, while the state officials feel very deeply the importance of highway improvement they also feel that highways can be made to cost too much not only in the price of work itself but by causing an undue increase in the cost of other production.

Observation of half a score of paving operations, including both force account and contract work, discloses no radical departure from familiar methods nor much evidence that practice is approaching a standard. About all the plant arrangements and construction procedures which are commonly employed can be found on any half-dozen operations visited at random. Despite all the developments in equipment and methods for handling raw materials to paving mixers it is astonishing to note the frequency with which shoveling to

wheelbarrows is chosen, and still more astonishing to have it asserted that in actual construction both last year and this year this so-called antiquated method has turned out more pavement per day per mixer and has used less man power per square yard of concrete than many of the modern outfits.

At the beginning of the year a 400-mile concrete road program was planned, but a survey of the materials and transportation situation led almost immediately to cutting the planned mileage in half. A further curtailment has been brought about by necessity and probably 100 miles is a liberal estimate of what the year's work will be.

Materials Shortage

By all accounts the shortage of concrete materials, due to lack of transportation, has been serious. Cement shipments have not been over 50 per cent of the program requirements, and where the supply of sand and gravel has depended on the railways the shortage has been about as great. This curtailment of the supply of commercial aggregates has led to extra effort (1) in locating and investigating local deposits convenient to planned roads and (2) in developing and equipping pits, particularly on the force-account operations previously mentioned. Three or four survey parties, of one engineer and one geologist, have been in the field for most of the season locating sources of materials. Incidentally it may be noted that, to conserve cars, the highway department is eliminating rejection at the job siding by inspecting all materials at the plants.

Maintenance—With construction conditions as related, the importance of maintenance of the older forms of surfacing has increased. Maintenance, indeed, has been the big task of the year: for the roads came through the winter of 1919-20 in worse condition than usual because of frost, and the rains of spring and early summer were so frequent and heavy as to hinder efficient patrol work. Wisconsin practice, broadly speaking, favors team patrol. This year patrolmen were in some sections difficult to secure, and where this condition prevailed the counties have resorted to motor-truck patrol, placing a truck and the necessary equipment on about 20 miles of trunk highway, and have secured excellent results.

Efficiency of Patrol Maintenance

In general, the evidence is that, despite the difficulties, road maintenance in 1920 excelled that of 1919. This result is credited largely to the patrol system put into operation in 1918. Figures of the 1920 expenditure are only approximate, but in round numbers about $2,000,000 will be spent in maintaining 7,200 miles of trunk-line highways. The lowest amount that any county will receive will be $150 per mile and the highest $275. These expenditures are on trunk-line highways only. Perhaps another $2,000,000 will have been expended on off trunk-line roads.

Enumerated, the outstanding impressions gained of Wisconsin highway practice in 1920 are: (1) A comprehensive experiment in force account-concrete road construction with a correlated development of roadside sources of bulk materials; (2) a contracting policy which discourages holdover contracts and prevents inflation of costs to upset local labor conditions; (3) an intensive development of patrol-maintenance operations; (4) a definite policy not to seek immediate mileage of hard surfacing at costs unjustified by economic values in a broad sense.

MICHIGAN is building this year some hundreds of miles of trunk-line gravel road. This construction is considered sound economics and good engineering. The roads being built, however, are not the gravel-surfaced trails of past years. They are full-width highways, with corrected alignment, permanent grades, culverts and bridges and complete drainage, *as perfect in detail in respect to roadbed structure as they would be made for a hard surfacing of concrete or brick or asphalt.*

With 6,000 miles of trunk-line highway it is held humanly impossible for some years to hard surface all the mileage, even if present traffic warranted hard surfacing throughout at the high prices which prevail. On a large mileage pavement is not required by present traffic, and perhaps will not be required for a long time. Meanwhile a gravel road, well constructed, will give for its life of three to five years, *if well maintained*, a very satisfactory thoroughfare for heavy traffic. And this road is constructed at a cost, for surfacing and surface maintenance for its natural life, about equal to the interest on the investment required for a concrete pavement. On this reasoning is based the claim that gravel-surfaced trunk-line construction is sound economics.

First Operations Permanent

It is good engineering, it is believed, to have permanent grade and structures built well ahead of expensive hard surfacing. Time is given for consolidation and for defects to develop. When the occasion for hard paving arrives there is needed generally only a dressing of the gravel surface and the pavement can be laid. Structurally there is value to any hard pavement in this sub-base of gravel, particularly where the soil is of clay or a clay mixture. In fact, it is wondered if this gravel layer compacted by travel on a grade which time has settled to permanent position is not itself a sufficient base for an asphalt surfacing. Michigan will undertake some experiments to determine the possibilities.

Much care is given to the selection of the gravel for the surface construction. First a *screened* gravel is employed, all large stones being removed, and, second, a *sand* gravel is chosen. A clay gravel, it is considered, does not wear as well and about its only superiority is that it packs more quickly under a roller. But these gravel roads are not rolled; they are left to be compacted by travel. With close attention to surface maintenance from the beginning the traveling public, it is found, does not object to its imposed task of consolidating the surfacing. In two seasons the task is completed. The gravel layer is 7 in. thick.

A word about Michigan gravel-road maintenance is warranted. It is not unusual in method; it simply is continuous. It consists of grader and drag work, with applications of calcium chloride to keep down the dust. Generally the road is treated with 1 lb. of chloride per square yard and later in the season with ½ lb. additional. Incidentally, the high price this season of the granular chloride has proved a rather serious setback to its use. Recently a flake chloride costing about half the cost of the granular product has been tried, and results are being observed. An ordinary fertilizer distributor is used for applying the chloride.

So extensive a program of gravel-road construction does not mean that hard surfacing is being neglected. Indeed, there is in hand an impressive mileage of concrete and of asphalt on concrete base. Progress on these projects has been hampered by slow deliveries of materials, although local producers and emergency methods of transportation have been utilized as far as the conditions would warrant. In some instances cement has been shipped from ports on the southern end of Lake Michigan through the Straits of Mackinac and down Lake Huron to ports on the eastern shore of the state.

Hard-Paving Projects

A survey of specific hard-paving projects discloses little that is unusual in construction methods or equipment. A record worth mention, perhaps, has been made on one project by the outfit described in *Engineering News-Record*, Oct. 2, 1919, p. 658. This year the contractor is using a finishing machine and also stock piles over a tunnel, at his loading yard, but in other respects the equipment has been changed but little. On a record day's run this outfit placed 1,031 ft. of 18-ft., 8-in. slab in one shift. With materials available, a 700-ft. daily run is held normal. As a bonus to increase output the contractor is paying each man on the job 1c. a foot for every foot exceeding 700 ft. in a day's run. Good results have been had with this bonus system.

Because of its heavy construction and its importance as a link in the main Detroit-Chicago route a 25-mile operation between Ann Arbor and Jackson deserves notice. This is an 18-ft. asphalt-on-concrete-base highway through a hilly country and is notable for its heavy earthwork. Local gravel pits are being developed for concrete aggregates and most of the base will be put in by the industrial-railway dry-batch-haulage method. Cement trucked from a local mill and handled in bulk will be used. The construction is by force account. The equipment problem on this job was considerably simplified by the use of surplus war material, particularly locomotives and cars, obtained by the state.

War Equipment—War equipment generally has been managed by the state with the view of obtaining from it the most intensive service practicable. Uses have been devised with considerable ingenuity, for even the most unaccommodating of the articles received. An example is the remodeling of some thousands of steel stakes or posts designed for barbed wire entanglements to serve as standards for highway signs. Two policies have contributed to this intensive service: (1) All equipment is repaired and, if necessary, is reconstructed before it is distributed for road work; (2) distribution has been made on the basis of no profit to the highway department. A county, for example, receives a motor truck for what it has cost to deliver that truck, including an overhead charge.

An old motor-truck factory at Charlotte, Mich., has been rented and fitted up as a repair shop and storehouse. The donated Federal equipment was delivered here, including some 600 motor trucks and automobiles, a large stock of miscellaneous truck parts and a variety of other material. Credit was secured from the State for a revolving fund for financing the plant operations, and a superintendent, with twenty-five or thirty mechanics and helpers, was put in charge.

The major operations at the Charlotte plant have been the repair and reconstruction of motor trucks. A truck upon receipt is inspected and all the work to be done is noted on a card which is attached to the truck when it is delivered to the shop crews. Generally the large items are the replacing of the old body with a horizontal dump body and the painting of the truck. Including the charge for overhead, the counties are getting the revamped trucks at a cost of $800 to $1,000, and are accepting them eagerly.

Excellent gravel-road construction, maintenance and service is the vivid impression of Michigan highway practice in 1920. A conservative hard-surfacing program covering main traffic routes and highways tributary to industrial centers is being developed without seeking extensive mileage and with liberality in types of construction employed.

Relative Economy of Wood, Steel and Concrete for Ore Docks

ORE DOCKS of steel and concrete construction are so much more economical than timber docks in both first cost and subsequent charges that no more docks of this last type are likely to be built on the Great Lakes. This prediction was made by R. C. Young, chief engineer of the Lake Superior & Ishpeming Ry., in a report on maintenance of ore docks, presented at the recent annual meeting of the American Railway Bridge and Building Association and including statements from several engineers.

When this railway was preparing to build a new ore dock in 1910, estimates were made of the first cost and maintenance charges for a period of 30 years for different types of docks, it being assumed that docks of permanent construction might be retired at the end of that period on account of obsolescence. For comparison it was assumed that a second timber dock on a new foundation would be necessary about the fifteenth year, to insure always having a dock ready for operation. This would give a life of about 16 years each for the timber docks. With the first cost of two timber docks taken as 100, the cost for concrete and steel docks would be 70 and 76 per cent respectively. In the same way taking first cost, repairs, interest, insurance and taxes for a term of 30 years as 100 for the two timber docks, the figures for concrete and steel docks would be 56 and 62 per cent respectively.

Mr. Young stated also that the increases in material and labor costs has been so much greater than was estimated in 1910 that the comparison at this time would be even more favorable to the permanent structure. He intimated also that 15 years was not necessarily the limit of life for a timber dock.

A life of considerably more than 15 years for timber docks is given in the same report by L. J. Anderson, supervisor of bridges and buildings, Chicago & Northwestern Ry. Assuming that repairs are made from time to time, in about 15 years it will be necessary to renew the A-frame deck or that part of the dock above the posts, especially if no treated timber has been used. The dock then is good for 10 or 15 years more, with ordinary repairs made during this period. The use of treated timber by this railroad for parts which are expensive and difficult to renew has reduced the maintenance materially, the treatment practically doubling the life of the timbers. Care in detailing may also reduce materially the difficulty and cost of renewing individual parts.

Defects in Current Meters and a New Design

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ALTHOUGH current meters have been in more or less general use in this country for the past thirty years, few modifications in design have been made with a view to obtaining greater capacity and reliability. Perhaps the main reason for continuing to operate these imperfect instruments is that until recently they were mainly used to measure the flow of water in river channels where the velocities were high rather than low and where conditions were such that accurate results could seldom be obtained. In more recent years, however, the use of current meters has been extended to measure the velocity of water in artificial channels of all kinds and more particularly those pertaining to irrigation and drainage systems. The mean velocities of flowing water in these artificial channels vary as a rule from 1 to 4 ft. per sec, and the requirements as to accuracy are usually much more rigid than is the case with river measurements. It is in connection with the measurements of water in these artificial channels, in which the water moves at a relatively slow rate and in which it is often confined to small cross sections, that the defects of the common types of commercial meters are most apparent. The purpose of this brief article is to call attention to some of these defects, to outline the requirements of a meter suitable for irrigation and drainage ditches and to describe some features of a new design of meter which is being developed to meet the requirements of relatively low velocities and small channels. This new design is the result of experiments carried on by the authors of this paper.

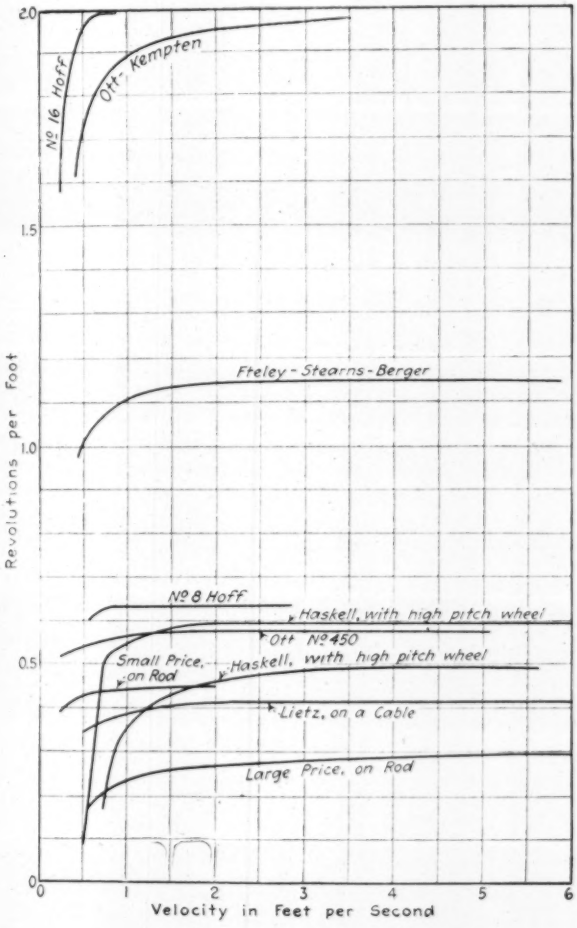


FIG. 1. STARTING-VELOCITY CURVES FOR CURRENT METERS AS AFFECTED BY INERTIA

The curve for the ideal meter would be a horizontal line indicating an identical number of revolutions of the turbine for all velocities.

The fundamental theory of current meters is based on the assumption that the flow of water is parallel to the axis of the channel. Accordingly, in rating a meter, it is moved with a uniform motion through a body of still water for a given distance, and the revolutions of the wheel or propeller recorded. These revolutions and the corresponding velocities, when computed and plotted as coördinates, determine the rating curve. Water, however, rarely moves in the manner assumed by some mathematicians and hydraulicians. Instead of advancing in straight lines, parallel to the direction of flow, the motion of its filaments is in irregular curved lines, the tangents to which form angles of varying degrees with the axis of the channel or stream bed. In the case of artificial channels, the tendency to create revolving motions with cross currents and eddies is augmented by the existence of curves, drops, turnouts and other structures. Thus it is evident that the manner in which water ordinarily flows presents serious difficulties in current meter design, which must be overcome in order to record the axial components of the filaments of water and eliminate all components at right angles to the direction of flow.

Other imperfections of commercial meters are caused by the obstruction they present to water in motion. It is well known that even small obstructions produce eddies and cross currents. As evidence of this fact, a wire 0.06 in. in diameter was placed in a vertical position in the water at a distance of 6 in. in front of a current meter which was being rated. The effect of this small wire introduced an error of 3 per cent in the rating. It would therefore appear that large, bulky meters indicate faulty design, more particularly for the smaller channels, owing to the obstruction which they present and also to the impracticability of measuring bottom currents and the inaccuracies introduced in attempting to measure top currents.

In rating a meter, the meter is rigidly attached to a rod and both moved through a vertical plane. In operating a meter, it may not be held in a vertical position, and in the case of tail meters the impact of moving water may cause a deviation between the axis of the meter and that of the stream. These modifications of the position of the meter when rated constitute another defect. Still another defect in the common types of meters is occasioned by their lack of accuracy and reliability until the influences which retard starting are overcome. Most rating curves of meters may be divided into two parts. From zero to velocities ranging from 1½ to 3 ft. per sec., depending on the type of meter, forms the first part and the second part extends from the end of the first to velocities up to 10 ft. or more per second.

In discussing the requirements of current meters

adapted to relatively low velocities and small channels, chief consideration will be given to ways and means of overcoming existing defects in such instruments. In regard to types, the cup meter possesses several good features. It is simple in design, has a low friction factor and does not readily clog with weeds or other foreign matter. Such a meter would fulfill most of the necessary requirements, providing water flowed in right lines, parallel to the axis of the channel. As has been stated, water seldom, if ever, flows in this manner and since all currents, irrespective of their direction, tend to cause the wheel of the cup meter to revolve, over-registration may vary from a mere trifle to as high as 10 per cent, depending upon the direction of the various filaments of water as they approach the moving part of the meter. There is apparently no way of overcoming this defect in the cup meter and it was regarded as being so objectionable for the conditions under consideration that the propeller type of meter was selected for the new meter. This meter, it will be observed, is acted upon, not by the full force of all currents, as is the case with the cup meter, but only by the axial components of the down-stream currents. This being regarded as an essential requirement in a good meter, this type was used as a foundation on which to construct the new meter. The tendency of the propeller or screw type of meter having a horizontal axis is to under-register. This is due to the readiness with which the axis of the meter may be shifted by its own rotation out of its true position parallel to the channel. A necessary requirement of a reliable meter is that the position of the meter when used to measure water in motion be relatively the same as that when it is being rated.

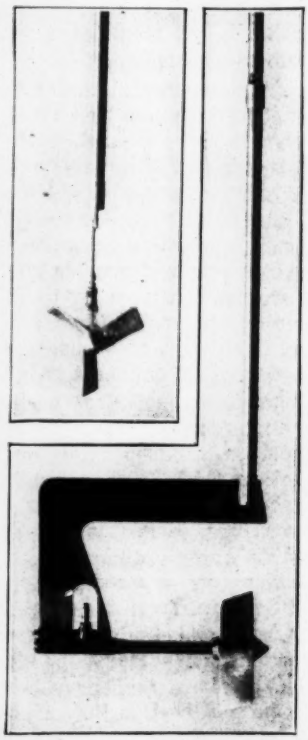


FIG. 2. SIDE AND END ELEVATIONS OF HOFF CURRENT METER

Another requirement calls for a meter of small volume which will present the least obstruction to flowing water. Current meters are often used to measure ditches in which the depth of water is less than one foot and in determining the mean velocity of any vertical section it is important, where accuracy is concerned, to measure top and bottom velocities as well as those between. Furthermore, unless the size of the meter is negligible in comparison with the cross-section of the channel, inaccuracies will result, since the immersion of a large meter in a small stream not only changes the direction of currents but modifies their effects.

To reduce the friction created by the moving parts of a meter to a minimum constitutes still another requirement. Some of the wheels or propellers of meters now on the market move under minimum velocities of about 0.2 ft. per sec. but the motion is erratic and not uniform until velocities ranging from 1.5 to 3.0 ft. per sec., depending on the type of meter, are reached. By constructing a special floatation meter, the eccentricities of the ordinary meter at the lower velocities were determined and these have been plotted on a large scale in Fig. 1.

Starting Velocities

These curves show the starting-velocity curves for various meters, as affected by the inertia of the moving parts. These curves also show that after a certain critical velocity is reached the turbine revolves a given number of times for each foot the meter is drawn through the water, regardless of the velocity. This critical velocity, at which the curve becomes horizontal, approaches zero as the meter approaches the ideal, from an inertia standpoint. The starting-velocity curve is important for the reason that the rating curve of any particular meter on which stream measurement is based becomes erratic and unreliable below the above mentioned critical velocity, the rating curve being closely related to the starting-velocity curve.

As a result of extended tests, the new meter (Hoff meter) shown in Fig. 2 seems to fulfill most of the requirements of an accurrate and reliable instrument adapted to small as well as large channels and to low, medium and high velocities. The instrument is so designed that it will have the least possible eddy-forming parts.

The forces which cause the propeller to revolve are derived solely from the axial components of the down-stream currents. By placing the axis of the meter support directly above the propeller, the errors caused by deviation of the horizontal axis of the meter are eliminated. Instrumental friction, the most serious objection to this type of meter, is reduced to a minimum by the selection of material having a specific gravity equal to that of water. Lastly, the simplicity of the design lessens the first cost of such instruments and tends to maintain a high operating efficiency.

"Acetol" New Gasoline Substitute

In addition to natalite, which is manufactured in Natal from the refuse of the sugar-cane mills and used extensively in propelling motor cars in South Africa, there has recently been produced another motor fuel to meet the shortage and high cost of gasoline in that country. The basis of this new fuel, which is called "acetol," is alcohol and ether, which comprises 90 per cent. The other ingredients are treated as a secret until the patentee receives his patent rights.

It is said that this fuel apparently solves the question of the air-cooled engine. No carbon sediment is formed in the cylinder, and the fuel is claimed to be non-injurious to the carburetor and engine. No special carburetor is required. Acetol mixes with gasoline. The inventor claims that it has a wider explosive range than the ordinary marketed gasoline, *i.e.*, both a weaker and an overrich charge in the cylinder heads will fire when gasoline fritters out or chokes. Tests made with this fuel are said to have produced very satisfactory results.

It is claimed that acetol can be manufactured much more cheaply than the present cost of gasoline in South Africa. The retail selling price of gasoline at the coast ports of this country, which is fixed by the government, is $1.12 per imperial gallon (1⅛ American gal.) if purchased in cases of two cans containing 4 gal. each, and $1.22 per gallon if purchased in smaller quantities. Natalite now sells for 60c. per gallon.—*Commerce Reports.*

Sixty-Year-Old Iron Bridge in a New Jersey Village

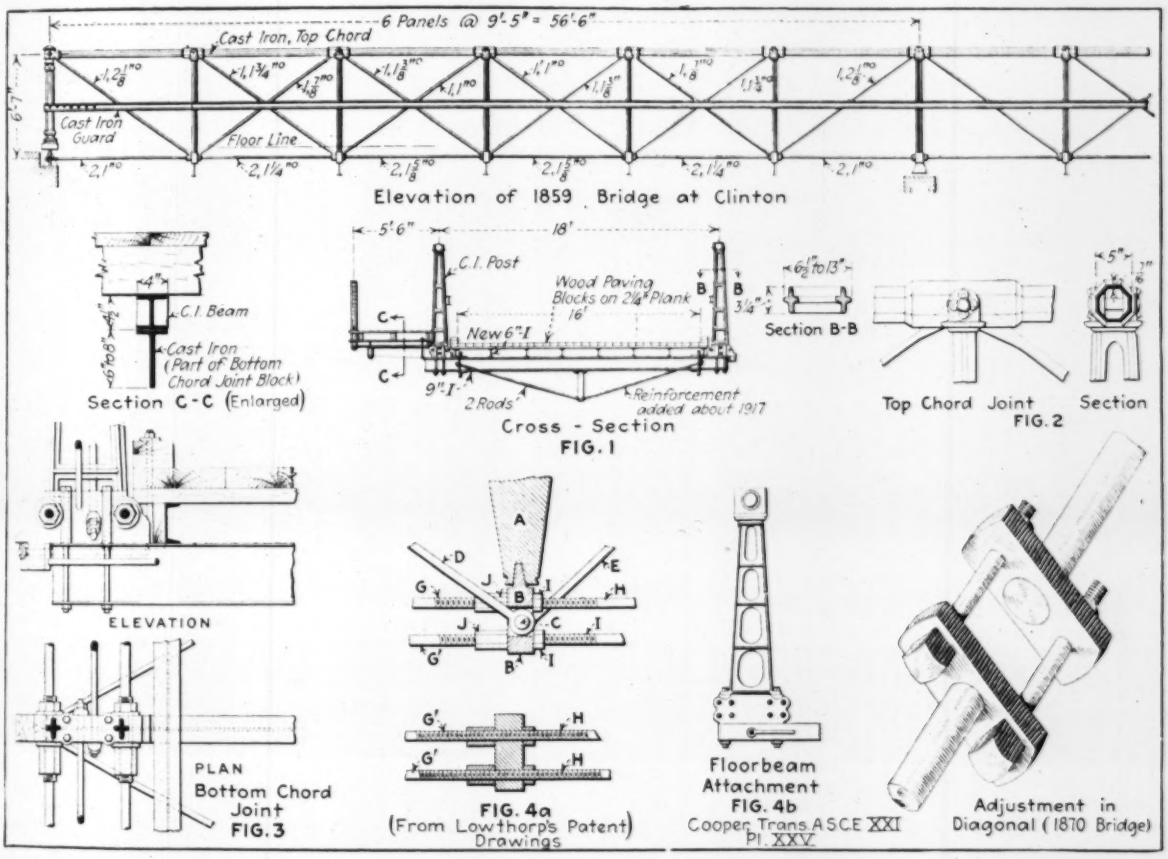
Oldest of Several Lowthorp Truss Highway Crossings of Raritan at Clinton and High Bridge Carries Regular Road Traffic—Floor Recently Strengthened—F. C. Lowthorp a Pioneer Iron Bridge Builder

By R. Fleming
American Bridge Co., New York City

IN THE village of Clinton, N. J., are two iron bridges built in 1859 and 1870, respectively, that interest the engineer not only by their age but also by their type. The older of the two, though it has seen full sixty years of service, is still in excellent condition, with no discoverable change of importance except a recent strengthening of the floor system. These structures represent an early type of iron bridge, now long extinct but at one time extensively used; little mention of the type is found in the writings of our standard authorities on bridges, though Francis C. Lowthorp, its originator, was a prominent bridge builder of his day. The type furthermore is an excellent representative of the combination structure of cast and wrought iron which played so large a part in bridge construction about fifty years ago, dominating the field for a time.

Both the bridges mentioned cross the South Branch of the Raritan River; the 1859 bridge consists of three spans of 56½ ft. each, and the 1870 bridge of two 85-ft. spans. Two other Lowthorp bridges over the same stream at High Bridge, some miles distant, bear the dates 1867 and 1868. Most of the illustrations given in the following, however, relate to the older of the two bridges at Clinton.

As shown by the drawing Fig. 1, made from measurements taken at the site by the writer, a Pratt web system is used in the bridge (the Pratt patent was issued in 1844). The compression members (top chord and posts) are of cast iron, while the tension members are of wrought iron. In sections of the top chord is cast the inscription, "Built for Hunterdon County by Wm. & Chas. Cowin, Lambertville, N. J., 1859. Lowthorp's Patent June 30 & Nov. 3, 1857." Because of the increasing traffic loads, the floorbeams were reinforced by kingpost trussing in 1917 or '18, as shown in the cross-section, and steel joists were added. As the road was being macadamized, wood paving blocks were laid on the plank floor. So far as determinable, all the rest of the bridge is old.



FIGS. 1 TO 5. LOWTHORP HIGHWAY BRIDGE OVER SOUTH BRANCH OF RARITAN RIVER AT CLINTON, N. J., BUILT IN 1859

Fig. 2 shows a top-chord joint and Fig. 3 a bottom-chord joint. This same bottom-chord joint is shown in the photograph of an intermediate post, Fig. 6. Mr. Lowthorp's patent of June 30, 1857 was based on a bottom chord joint as shown in Fig. 4a (reproduced

from Patent Office Report, 1857). The claim of the patentee is, "The straining piece *B*, in combination with the rods *G* and *H*, when the latter are connected to the plate substantially in the manner set forth, and when the said plate is arranged to receive the vertical or verticals *A* and *D*, *E* of iron truss frame bridges."

The floor beams are 9-in. wrought iron I's with 4-in. flanges and ½-in. webs, now reinforced by trussing. They are fastened at each end with 4 bolts to the cast iron "straining piece." The beams bear the imprint, "Patented Dec. 1, 1857." The main and counter diagonals have screw adjustment at the lower ends, and the bottom-chord rods are connected longitudinally with screw "swivels" or sleeve nuts at each panel-point. All screw ends are enlarged. The diagonal bracing in the plane of the bottom chord consists of a pair of rods in each panel.

The workmanship of the bridge was excellent. This is evidenced by the fact that it has lasted 60 years and is still in good condition. The bridge presents a much better appearance today than the majority of pony trusses built at a later date. It is, however, frequently overloaded. During the two hours while measurements were being taken there passed over the bridge 35 automobiles, 2 auto-trucks and 2 teams, and later in the day a large moving van from a city 50 miles distant. The writer was told of an auto-truck that crossed a day or two before loaded with 12 tons of cement. Even allowing for exaggeration in this statement, it confirms the writer's opinion that auto-truck loading unless more effectively restricted than at present will result in the failure of this and other old highway bridges.

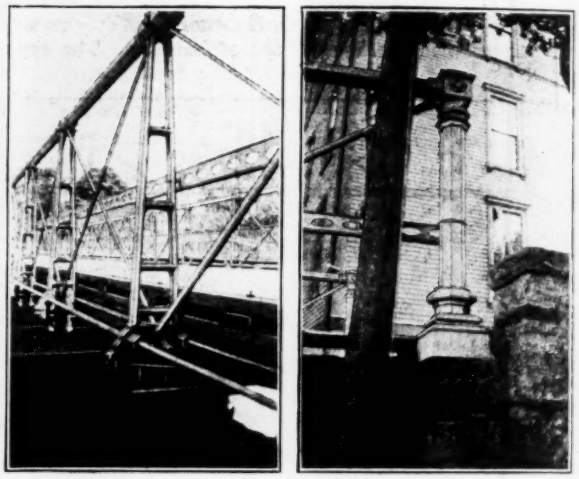
As well as can be judged, the bridge was probably designed to carry a moving load of 50 lb. per sq.ft. on the roadway. The floorbeam reinforcement and the wood paving blocks add 12 or 13 lb. per sq.ft. to the original dead load. Considering the total dead weight of the present bridge to be 900 lb. per lin.ft. (of which 525 lb. is carried by the walk truss) the reader can easily make his own calculations for permissible loading. The heavy moving loads of today were unknown 60 years ago.

The 1870 bridge, "built by Wm. Cowin, Lambertville, N. J.," is of the same type as the 1859 bridge. The truss that was measured is 9 ft. deep center to center of chords and is divided into 8 panels of 10 ft. 7½ in. each. The diagonals in each panel are of two rods instead of one as in the older bridge, and pins are used in bottom as well as top chord. An occasional pair of main diagonals has the adjustment in one rod shown in Fig. 5. Just when this peculiar form of adjustment at irregular intervals throughout the four trusses was made is not clear.

It may be fitting to give some general facts regarding the Lowthorpe bridge, of which type a considerable number were built in the '60s and '70s. They were designed in accordance with correct engineering principles. The type of truss, known as the Lowthorp Trapezoidal Truss, was of either Pratt or Whipple web arrangement, and had counters in all except the end (sometimes the end two) panels. The compression members were of cast iron and the tension members of wrought iron.

Mr. Lowthorp was a firm believer in the merits of cast iron. A paper, "On the Use of Cast Iron for Compressive Members of Iron Bridges," read by him at the second annual convention of the American Society of Civil Engineers, held June, 1870 (*Transactions A. S. C. E.* Vol. 1, page 228) closes with an interesting expression of opinion: "The practical experience of most engineers and builders will justify me in the assertion that there is much more to be feared from defects in wrought iron used for tensile than in cast iron used for compressive purposes."

A commission appointed by the city of Philadelphia (Ashbel Welch, J. Edgar Thompson and John C. Cresson) in 1858 offered a premium for the best design of an iron bridge truss. In awarding the first premium to Mr. Lowthorp it said of his design, "It is well porportioned in all its parts, which are so disposed as to afford a maximum of strength with the smallest amount of material, having such arrangement for adjustment as to give each and every part its proper function to perform, without requiring great experience for its care."



FIGS. 6 AND 7. INTERMEDIATE POST AND ABUTMENT POST

In 1856-7 Mr. Lowthorp designed and built his first railroad bridge. The bridge crossed the valley of Jordan Creek on the line of the Catasauqua & Fogelsville R.R. near Allentown, Pa. It consisted of 11 spans with a total length of 1,120 ft., supported on piers of cast and wrought iron varying in height from 30 to 54 ft. anchored to masonry foundations, making a total height in places of nearly 90 ft. The trusses, of the double-intersection type, 12 panels each, were 16 ft. high and were spaced 10 ft. apart center to center. At the time of its completion this was one of the longest if not the longest of iron bridges in the United States.

An interesting feature in many of the Lowthorp bridges was the hip vertical, where for uniformity in appearance a cast-iron member similar to the posts was used. Inside of this member was placed a wrought-iron rod to take the tensile stress from the floor beam.

While most of the Lowthorp bridges have been replaced as they were outgrown by the traffic loads, a 60-ft. deck span of three trusses, with 34-ft. roadway and two 7-ft. walks, still exists at the Jackson Ave. crossing over the tracks of the Central R.R. of New Jersey in Jersey City. A trolley traverses the bridge, but the trolley tracks, laid long after the bridge was built, are trussed beams extending from abutment to abutment.

In response to a letter of inquiry regarding Mr. Lowthorp and his bridges addressed to his son Francis C. Lowthorp, Counsellor at Law, Trenton, N. J., the latter has given many interesting details. From his letter the following extracts are taken:

My father, born 1810 in New York City, died June 1, 1890. He was a delicate child and was placed under the care of his uncle, the late Dr. John Lilly, of Lambertville, who succeeded in making a rugged man of him, putting him into an outdoor life as a surveyor and engineer. He worked under Ashbel Welch on railroad and canal construction for a time. He went into the service of the Lehigh Coal & Navigation Co. and designed and superintended construction of some locks in its canal with a great lift. Afterwards he became bridge engineer for the Lehigh Valley R.R. Co. Among other bridges he designed the first railroad bridge across the Delaware at Easton, connecting the Lehigh Valley R.R. with the New York Central and the Belvidere & Delaware R.R., a structure carrying tracks on two levels. In 1857, acting as engineer for Cartwright & Co., the contractors for the Catasauqua & Foglesville R.R., he completed the Jordan Creek bridge, not far from Allentown, Pa. This was very adversely criticised by some other engineers, and the prediction was made that it would fall with the first train to attempt its passage. It turned out to be one of the longest-lived bridges he ever built; I think it stood for about fifty years, despite the constantly increasing weight of rolling stock.

Some years after the completion of that bridge my father started into the engineering and contracting business on his own responsibility. He used compressive members of cast iron, as you know, and held to that plan for many years despite the competition of others who used wrought-iron (and afterwards steel) compressive members.

According to the same authority, Mr. Lowthorp designed more than a score of bridges for the Newark & New York R.R. when this was built, and most of the bridges on the New York & Long Branch R.R. These latter included the Raritan Bay crossing, containing a swing span that was probably the longest ever built up to that time. He also built the original Newark Bay draw of the Central R.R. of New Jersey, besides other bridges on that road, and several bridges for the New York, New Haven & Hartford R.R.

Mr. Lowthorp took out patents on his designs of swing bridge centers and turntables; the latter in particular came into wide use, some twelve being furnished to the Union Pacific alone.

While the Raritan Bay draw was replaced after very short use, its removal and replacement by another bridge was not chargeable to any defect in the design or any structural objection to the bridge, but resulted from competitive railroad policy. Immediately after its erection, litigation developed, in the interests of the Pennsylvania R.R., which was engaged in a campaign to obtain an interest in or control over the Long Branch road to secure access to the seashore resorts. The claim was made that the bay crossing constituted an obstruction to navigation. After the success of the campaign, the bridge was replaced by a new structure.

Distribution of Snake River Water During Greatest Drought

Continuous Flow Supercedes Intermittent Flashes —One Man Handles Storage and Natural Flow Like Train Dispatcher

THE Snake River in Idaho is one of the State's greatest resources since it supplies water to a large percentage of the total irrigated area. Policing the stream and distributing the water to the respective users in accordance with their rights is one of the most important duties of the state. From Jackson Lake storage reservoir on the headwaters in Wyoming to the Milner dam, by which the two Twin Falls irrigation companies divert the last of the stored water, the distance is 300 miles. Intervening are more than 50 headgates, which

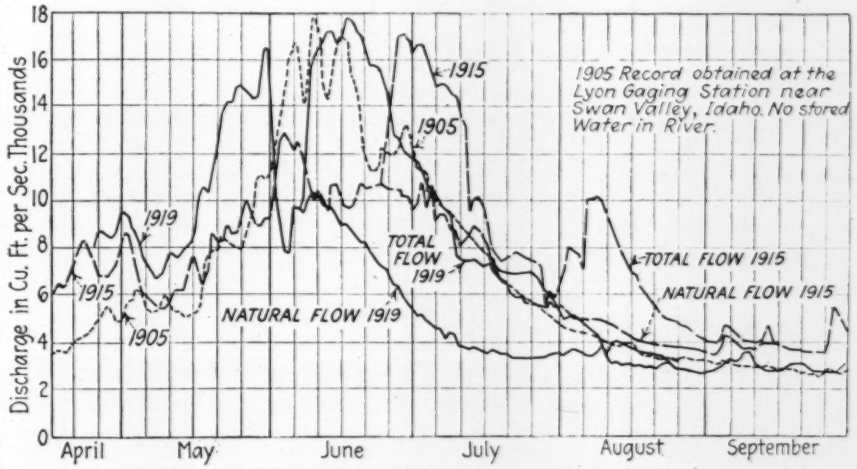


FIG. 1—TOTAL AND NATURAL FLOW OF SNAKE RIVER AT HIESE DURING THREE YEARS OF DROUGHT

by court decrees have priority rights of various dates. To apportion the stored water and natural flow properly to the rightful owners when there is not enough to go around and late decrees must be cut off in successive order is a difficult task. It requires an intimate knowledge of the hydrography of the river, backed up by daily readings at the numerous gaging stations, and necessitates frequent changes of the canal headgates and storage reservoir outlet gates. Like a train dispatcher, the officer in charge of the distribution turns loose in a continuous flow a definite quantity each day and must order the proper number of gates opened to care for it as well as the natural flow, plus or minus the amounts gained or lost in transit. Unlike the train dispatcher, his container as well as cargo must all be delivered at the end of the run.

Only within the last two years has one man been placed in complete control of the whole river but the results have been so satisfactory it is not likely multiple control will again be revived. By a co-operative arrangement effected with the U. S. Geological Survey, it became possible to centralize under the control of one man both the hydrometric or stream measurement work and the distribution. This consolidation of State and Federal functions is a departure from the old method and has a distinct advantage in that there is no lost motion in obtaining the fullest and most complete information concerning all phases of the river work. Another

advantage is the continuance of the same administration from year to year, thereby tending to promote greater efficiency in the handling of the work and to develop better methods each year. W. G. Swendsen, commissioner of reclamation, is charged with the duty of administering the water resources of the state and has designated G. Clyde Baldwin, of the U. S. Geological Survey, a special deputy to handle the Snake River problem as a whole. The latter's annual report for 1919 (not printed) has recently been made available. Since it contains the essential features of how the problem was solved during the dryest year of record, the following abstract has been prepared:

The excess of requirements for irrigation over run-off in the valley during the season of 1905 served to establish the fact that definite determinations of the relative priorities of water rights for the pioneer was essential, and that storage was necessary if water rights throughout the entire irrigation season were to be assured to later developments. Thereupon courts fixed the amount of water allowed and the priority dates of each of these early rights. Construction of storage reservoirs at Jackson Lake and on the Upper Blackfoot River was started in 1906. When the U. S. Reclamation Service completed the first Jackson Lake dam for the use of the Minidoka Project and started to utilize the natural channel, beginning in 1908, the equitable distribution was complicated immeasurably by the necessity of segregating the stored water from the natural flow.

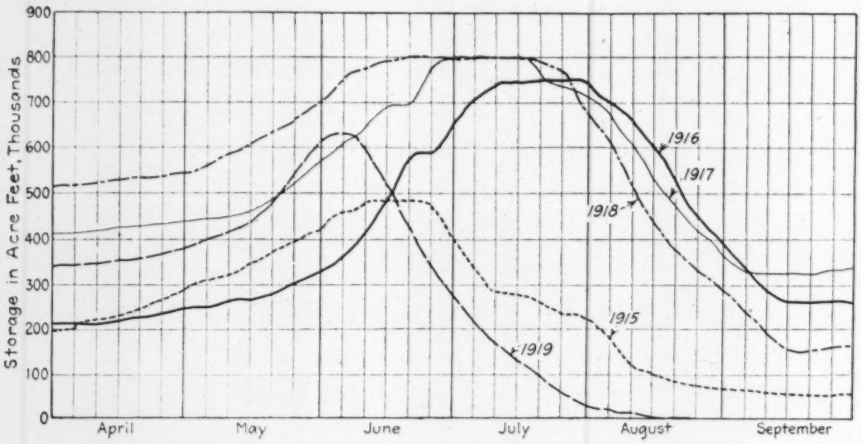


FIG. 2. HYDROGRAPHS FOR JACKSON LAKE SHOWING EARLY DEPLETION IN 1919

Since 1908 Jackson Lake dam has been twice reconstructed to increase its capacity to the present 850,000 acre-feet. Of this amount 102,000 acre-feet has been acquired by 15 different canals in the upper valley and 419,000 acre-feet by the two Twin Falls canals diverting the water at Milner. The remainder belongs to the Minidoka Project of the U. S. Reclamation Service and is diverted from canals leading out of Lake Walcott which acted during the first few years as a catchbasin and equalizing reservoir.

Early operation consisted in transmitting the stored water down the river from Jackson Lake in several flushes or heads with intervening periods during which only the natural flow was allowed to pass. At the end of the period of the flush, canals in the Idaho Falls-Blackfoot section were staked and locked to prevent improper diversion of stored water during the next flush. The plan was unsatisfactory to both the natural-flow and stored-water users. The frequent fluctuations of the river damaged diversion dams and made it difficult, as well as expensive, to maintain anything approaching a constant rate of delivery through many of the canals. On the other hand, during the flushes these canals were maintained at their staked

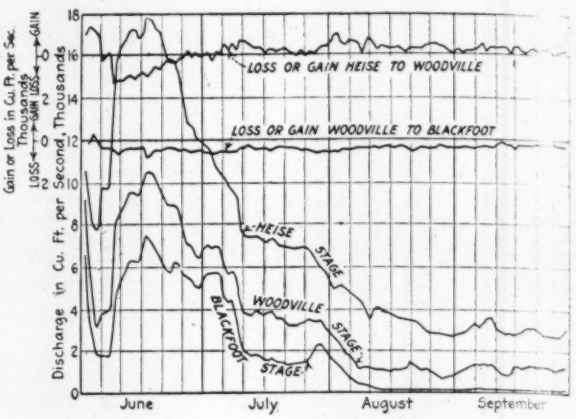


FIG. 3. HIGH RIVER STAGES PRODUCE LOSSES—LOW STAGES BRING GAINS FROM BANK STORAGE

elevations in spite of the normal decrease in the natural flow. Thus storage transmission losses were increased by the extra draft necessary to make up this natural deficiency.

Since 1912 the continuous-flow system has been in use. A steady flow is maintained varying only with the needs of the stored-water users and the limitations as to available supply and outlet capacity at Jackson Lake.

Allowance is made for time of transmission and loss in transit, and the canals having natural flow rights are regulated in accordance with the decrees or to insure proper storage deliveries each day. This plan involves the daily determination and frequent regulation of flow in each canal diverting from the river between Moran, Wyo., and the lowest point of use 300 miles down stream.

Through the U. S. Geological Survey a number of additional river gaging stations have been established to aid in the solution of the problem of transmission losses and return flow.

General Plan of Operation—In the general plan of operations daily reports were made either in person, by telephone or telegraph, for each of the important river stations and for all the canals except those located in the North Fork-Teton area. Each evening the deputy water masters, or river riders, were given any necessary instructions concerning regulation for the following day. A report showing the essential features of each day's deliveries was also mailed to the State Commissioner of Reclamation each evening.

Outline of distribution—Reports on the precipitation during the previous winter and the available snow in the mountains both indicated that a shortage of water for irrigation would be experienced during the season of 1919 but it was not realized in advance just how great this shortage would be nor how early in the season it would be felt. During the latter part of May the flow in the river increased in a normal manner until about the end of the month when, as a result of unseasonably cold weather, it dropped very rapidly. (The decrease at the Heise gaging station amounting to more than 8,500 sec.-ft. in a period of four days is shown on the hydrograph.) Jackson Lake reservoir still lacked more than 200,000 acre-feet of being filled to capacity, but in order to prevent an immediate shortage of water available to fill the natural-flow rights the outlet gates were raised on the afternoon of June 3 and the level of the water in the reservoir was held stationary until June 6, when the

first storage was released. The release of Jackson Lake stored water was purposely deferred and a heavy draft placed upon Lake Walcott in order to prevent possible wastage of water over Milner dam in the event that rains or a sudden rise in temperature should cause a corresponding increase in the discharge of the river. No material rise in stage accurred, however. In fact, beginning with June 9 (at Heise) there was a steady and, for the first month, very rapid decrease in the natural flow which persisted, except for slight checks due to rains, until the comparatively heavy rains of early September, when a marked increase was noted.

All canals were ordered cut to their decree amounts on June 4 and distribution was maintained on this basis until June 10, when, in order to fill all decreed rights, it became necessary to stop deliveries under licenses and permits. On June 11 decrees having a date of priority subsequent to Jan. 1, 1903, were also cut. Thereafter decreed rights were ordered cut until July 3, when all previous to May 10, 1889, had been included.

Coincident with the constant and rapid drop in the stage of the river, an increase in the return flow entering the stream between the Heise and Woodville gaging stations was noted and about this time what had been a net loss was converted into an appreciable net gain, which by July 5 proved to be of sufficient amount to warrant the restoration of the large right of the Idaho Irrigation District which bears the date of May 11, 1889. On July 8 this right was again cut about one-third, but it was not until July 19 that it was entirely cut off for the second time. Other cuts followed until by July 27 the natural flow was insufficient to supply any of the 1889 decrees. Near the end of the month, however, light rains occurred and these, combined with further decreases in the flow of the river, probably were responsible in part at least for another material increase in the return flow, to the extent that the latter reached its maximum for the season on Aug. 2. A large number of rights were, therefore, restored to good standing.

The storage in Jackson Lake was by this time very much depleted and from July 26 to July 30, and again beginning Aug. 3, all the outlet gates were reported to have been raised clear of the water. The water surface in the lake continued to drop, indicating that storage was still being drawn off, although at a continually decreasing rate because of the limitation of the outlet capacity and the lessening head.

Transmission losses between the Woodville and Blackfoot gaging stations were now very large in proportion to the small discharge of the river and it was soon discovered that the Minidoka canals could expect to benefit little from the small amount of stored water still being released from Jackson Lake. Instructions were therefore received to partially close the gates at the dam on Aug. 21 and thereafter so regulate them as to allow only the natural flow to pass on down the river. In anticipation of this cessation of stored-water delivery an agreement was entered into with the president of the Progressive Irrigation District under which a quantity of storage equivalent to the total of the unused upper valley storage rights was delivered to the canals of this district, to be later repaid, as required, by transfer from natural flow rights. No storage was released from Jackson Lake after Aug. 21 and the work of distribution after that date resolved itself into the problem of so regulating the natural-flow rights of the upper valley in accordance with the decree as to fill all valid rights up to the requirements and still not allow any water to waste past the lowest point of diversion near Blackfoot. This could not always be accomplished exactly, but it was so handled that during the greater part of the remainder of the season (until the end of September) the river was absolutely dry at a point about four miles below the town of Blackfoot, while at no time during this period did the waste past the last canal exceed about 100 second-feet.

Unusual Natural Run-Off—A brief reference to the extremely low natural flow of the river during the early part of the season and a few comparisons with other low water years will facilitate a clear understanding of the 1919 conditions. Very little snow fell during the early part of the winter of 1918-19 but storms during January, February and March served to accumulate a snow reserve in the mountains of nearly average depth, in so far as this could be determined from the reports available. At the beginning of the irrigation season, therefore, while a deficiency in available run-off was expected, no very alarming shortage was anticipated.

Analysis of the Heise station hydrographs covering the three low run-off years, 1905, 1915 and 1919, indicates that this idea was substantiated in a measure, in that while the natural discharge is materially lower during June and July, 1919, than for the corresponding months of the other years, this deficiency is made up in part by the higher discharge during April and May. In fact, if account is taken of the early run-off during 1919 which was stored in Jackson Lake, it is apparent that the total natural flow was greater for this year than for 1905. Unfortunately, however, the peak period of irrigation use came during the months of greatest comparative deficiency and little benefit was derived from the surplus available during April and May.

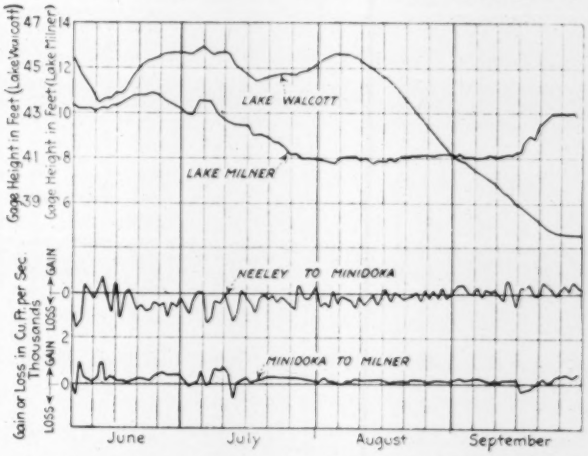


FIG. 4. LAKES GIVE UP APPRECIABLE BANK STORAGE AT LOW STAGES—LOSE AT HIGH STAGES

Attention is called to the fact that during most of June and July, 1919, the natural flow was no greater than for dates fully one month later during the other low years, and during the middle of this period the deficiency reached the astounding total of about 5,000 sec.-ft.—an amount equivalent to nearly one-half of all the rights decreed to upper valley canals which divert from the South Fork or main Snake River.

Enforcement of Regulation — In most instances no difficulty was experienced in enforcing orders for the closing of headgates. There were, however, a few exceptions where gates were raised by unauthorized parties after they had been lowered by the water master or by his deputies. In no case was any first hand or eye-witness evidence obtained in regard to infractions of the law. In default of this, prosecutions were not attempted. A number of headgates were fastened with chains and padlocks, but even these were not always effective, so that on three different canals guards had to be employed.

The threatened failure of crops on land under canals which had either been cut under the decree or else were soon likely to be cut naturally aroused much discussion. Meetings of the water users were held at frequent intervals, investigating committees were active and threats were even made to go out and take the water without regard to law. At times this situation appeared to be decidedly threatening and it was materially aggravated by the fact that the bulk of the Jackson Lake storage delivered to the lower valley canals was run down the river during what is normally the flood-water period. Efforts were made, however, fully to explain the existing conditions through

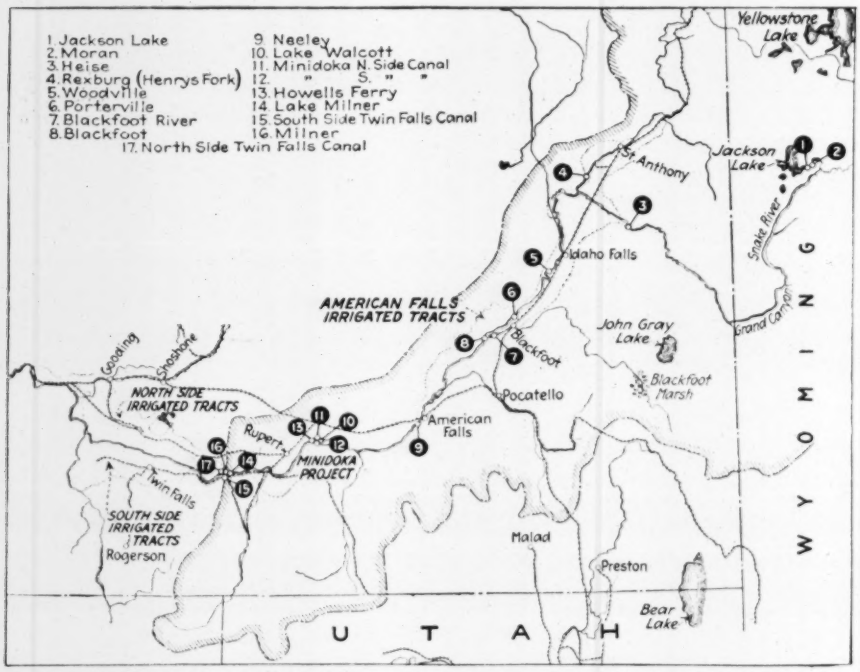


FIG. 5. SNAKE RIVER BASIN SHOWING STORAGE RESERVOIRS, IRRIGATED AREAS AND GAGING STATIONS

the medium of the press, at water users' meetings and by personal conversation with canal company officials. This last means probably was the most effective and although most of the time of the special deputy during ordinary daylight office hours for a period of about six weeks was taken up in furnishing information of this character, and an extra hydrographer had to be employed for a part of the season in consequence, the increased confidence and better feeling which resulted is believed to have afforded ample justification.

Domestic Water—Many of the settlers in the upper valley still depend upon the water in the canals for domestic and stock use; hence, when it appeared that some of these canals, under a strict interpretation of the decree, might be deprived altogether of water, this immediately became a vital issue. In June a general meeting was held at Idaho Falls, where it was explained to the water users that no legal authority for allowing domestic water to otherwise dry canals existed and that to do so would necessarily reduce the quantity available for irrigation use. After some discussion a vote was taken, from which it appeared that public sentiment was unanimously in favor of granting an allowance for domestic use when needed, but no action was taken to provide a specific source from which water for this purpose was to be obtained. Therefore, while domestic heads of water were granted thereafter in accordance with the decision of this meeting, in default of any authority to do otherwise, water for this purpose was taken from the natural flow available in the river. The total natural flow was consequently depleted and it became necessary to cut other rights in the order of their priority in order to make up this deficiency. Under this system, during the latter part of the season in particular, when the natural flow was almost stationary or was decreasing at a lesser rate than at first, the entire domestic allowance was supplied at the expense of the rights of a few canals which otherwise might have enjoyed the use of nearly a full irrigation right. Unquestionably this was unfair to these canals and in future years if domestic water cannot be dispensed with entirely it should be supplied on some other basis.

Temporary Transfers—In order to limit unavoidable crop losses throughout the valley to a minimum the State Commissioner of Reclamation, early in the season, authorized the granting of temporary transfers of water from canals still having valid rights to those in which the flow had been reduced. At first there seemed to be some reluctance to utilize this permission and instead efforts were made to secure an exchange with the stored-water owners whereby repayment could be made from the natural flow late in the season, as was done in 1915. This did not seem practicable, however, and even if arranged would not afford the necessary relief because of the small amount of storage which could be made available. Therefore, after repeated assurance had been given that these temporary transfers would in no way affect the decreed rights of the canals involved, they were very largely adopted and undoubtedly were the means of saving many valuable crops. Between the latter part of June and the end of the irrigation season more than one hundred of these temporary transfers were made. So far as known the water delivered under these transfers was always donated.

In spite of all the good resulting from this temporary transfer system it probably is detrimental to those decreed rights which are just past the dividing line or which would be restored in the event of any increase in the natural flow. The reasons advanced are as follows: (1) If the use of the water was confined to the land to which it had been decreed the ground water level in this section would rise higher and a larger return flow to the river would result than in the case where it is used on land which has been without water for some time. (2) During the latter part of the irrigation season many crops no longer require irrigation and the water requirements of any given right would be allowed to go on down the stream.

Transfers on the 1919 basis, therefore, tend to deprive certain canals of water which might normally be available to them and are probably only justifiable as an emergency measure which promotes a higher water duty.

River Data — Extensive tables were made to summarize the river data in regard to total flow, normal and stored water segregation, diversions, losses and gains for each section of the river between Jackson Lake and Milner. These tables are prepared upon the following time interval basis:

Time from Jackson Lake in Hours	Gaging Station	Period Used for Comparable Daily Means
0	Jackson Lake and Moran	Day ending at 4 a.m.
24	Heise	Day ending at 4 a.m. 1st day following
28	Rexburg	Day ending at 8 a.m. 1st day following
42	Woodville	Day ending at 10 p.m. 1st day following
48	Porterville	Day ending at 4 a.m. 2d day following
54	Blackfoot	Day ending at 10 a.m. 2d day following
68	Neeley	Day ending at 12 midnight 3d day following
92	Minidoka	Day ending at 12 midnight 4th day following
116	Milner	Day ending at 12 midnight 5th day following

While no one schedule for time of transmission will apply for all the different stages occurring during the irrigation season, it was thought that any attempt to vary the time interval with changes in stage would only lead to confusion, and as this schedule is fairly representative of average conditions it was used throughout the entire four months' period. On the upper river sections it is more directly applicable at medium and high stages, while below Neeley it apparently coincides better at low stages.

Jackson Lake Storage Deliveries—The amount of stored water released each day from Jackson Lake was measured at the Moran gaging station. The proportion of this total which was storage water was determined from the reservoir capacity tables by noting the quantity corresponding to the daily decrease in stage indicated by the lake gage readings. Interpolations were sometimes necessitated for short periods because of irregularities attributed to wind effect.

Special investigations carried on by the U. S. Geological Survey during the seasons of 1917 and 1918, between Moran and Heise, while not conclusive as to results, indicated that the stored water transmission loss between these two points was very small and probably did not exceed the average of 2½ per cent which has been applied for the last few years. Consequently this percentage was again used throughout the season of 1919. Below the Heise gaging station the former loss schedule of ½ per cent to Woodville and 5½ per cent to Neeley was abandoned in favor of computed losses based upon two-day means. The method of computing the percentage of loss for each day as follows:

$$\frac{U+T-D-L}{\frac{1}{2}(U+T+L)} = \frac{\text{Actual daily loss}}{\text{Approximate average flow in section}} = \text{Percentage loss}$$

Where U equals total flow at upper river station, T equals inflow from tributary streams entering within section, D equals total diversions throughout section, L equals total flow at lower river station.

The percentage actually applied each day to determine the stored water loss in a given section was the mean of the computed percentages for the two preceding days. Whenever a net gain instead of a loss was noted in a section the transmission loss for the stored water was assumed to be ½ per cent, on the theory that the stored water cannot gain in transit. Considering the data for the entire season, it would appear that this plan may have been somewhat detrimental to the storage owners, as under it they participate in any unusual losses but do not benefit from the return flow noted on certain sections of the river during the latter part of the season, even though this return flow may be caused in part by stored water which was dissipated into the ground adjacent to the river during the earlier or heavy loss period.

FIG. 6. RECORDING GAGE HOUSE CABLE AND CAR AT NEELEY IN USE SINCE 1910

Advantage was taken of large rock for foundation and anchorage for house, box type of float well and staff gage.

The original plan contemplated the pooling of all storage losses and their equal assessment between the canals of each group. This plan proved difficult, however, because of the different dates when individual storage rights became exhausted and the consequent uncertainty concerning the final total of the storage loss. Hence approximate total losses of between 6 and 7 per cent to Woodville and between 13 and 14 per cent to Blackfoot were used for the distribution. These percentages were calculated upon the assumption that the accumulated loss to stored water at the Blackfoot station over and above the amount legitimately chargeable (what might be termed the extra loss due to faulty regulation of the natural flow diversions) would be prorated between all storage rights. Few owners received exactly the amount of storage to which they were entitled after making proper deductions for transmission losses. The final discrepancies in most instances are due to computation revisions or to the impracticability of exact regulation to the nearest hour. The only gross error is chargeable to the special deputy who allowed the Harrison Canal to draw storage for one day in excess of its proportion. Summary of the totals shows that 93.7 per cent of the 102,000 acre-feet stored at Jackson Lake for the upper valley canals was actually delivered, while the average delivery to the lower valley canals when proper account is taken of the Lake Walcott exchange amounted to 86.2 per cent of the total credited to them at the reservoir.

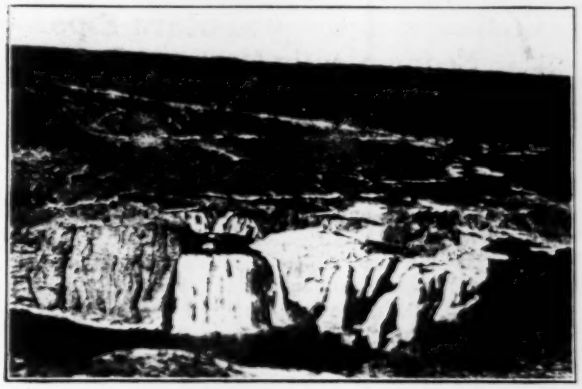


FIG. 7. ONLY THIN SHEETS OF WATER PASSED TWIN FALLS—IRRIGATION UPSTREAM CLAIMED ALL FLOW

The flow in the river at the Milner stations which represents the wastage past the Milner dam has been pro-rated and is included in the amounts charged against the two Twin Falls canals. Prior to Aug. 17 this wastage was divided between the two companies in proportion to their relative draft, but thereafter by special agreement $\frac{3}{11}$ was charged against the North Side canals and $\frac{8}{11}$ against the South Side Canal, this being in proportion to their relative ownership of the Milner dam.

Review Gains and Losses—A study of graphs showing losses and gains indicates that with a sharp increase in the flow of the river the losses also increase; with a sharp drop in the river the losses decrease or the gains increase. These facts are probably explained by the changes in the ground water which follow each marked variation in the stage of the river. The tendency for the losses to decrease in Lake Walcott with a corresponding drop in the reservoir and the reverse with a rise in the reservoir affords a good illustration of the effect of bank storage. From Aug. 4 to Sept. 30, when there was practically a steady drop in the elevation of Lake Walcott, there was an average daily net gain of 65 sec.-ft., whereas from June 5 to Aug. 3 there was an average daily net loss of 348 sec.-ft. If this latter quantity could be assumed to represent the normal loss in the reservoir which continued during the entire falling stage period the actual inflow attributable to return water or bank storage would average 413 sec.-ft. and would amount to the astounding total of more than 45,000 acre-feet in the last 58 days of record. Such an assumption is undoubtedly not warranted since the normal loss probably decreased with the drop in the water surface elevation, but it serves to indicate the possible extent of the additional supply derived from bank storage.

Eighty Applications for Power Permits

Eighty applications for preliminary permits and licenses have been received by the Federal Commission. The revision of these applications so as to conform with the requirements of the regulations is being carried forward rapidly and many corrected applications are now in the hands of the commission.

Cast-Iron and Wood-Stave Pipe Economically Compared

By J. W. Ledoux
Consulting Engineer, Philadelphia

THE cost of cast-iron water mains has been so great the past two years that much attention has been given to substitutes, and many concerns, especially those connected with war activities, have laid immense quantities of wood pipe to be subjected to all ordinary ranges of pressure, both constant and intermittent. It is quite probable that within the next generation some valuable records concerning the useful life of this material will be available. At the present time there is a dearth of reliable information as to its suitability for waterworks purposes. If one were to form a conclusion from a number of important installations he would be justified in condemning its use absolutely. However, he could find at least as many instances to indicate it to be superior to cast-iron pipe in many essential qualities.

Rod-banded continuous wood-stave pipe, properly designed and laid and kept filled with water, should last at least 25 years and be good for working pressures up to 100 lb. per square inch. Cast-iron pipe, when first well laid with lead joints, is practically water-tight, but after some years of service the frequent expansions and contractions due to changes of temperature are sure to cause some dropping leaks, but the total of this leakage is generally not large enough to be a problem. With wood pipe, however, there is almost sure to be a material amount of leakage, and the question is how much is permissible. If water is scarce and precious and the loss due to leakage is not returned to the same drainage area or for any other reason leakage cannot be tolerated, then it will be unwise to use wood pipe at all; but let us suppose that the leakage is recoverable and only causes reduced capacity, or increased cost of pumping, such as would happen if this leakage came back into the drainage area or if the water were pumped from an inexhaustible supply, such as a lake or river.

Let us take an example of 40,000 ft. of 24-in. wood pipe, which, at today's prices, can be laid for about $3.50 per foot. Let us assume the life to be 25 years and the depreciation such as will renew the pipe completely at the end of that time. In order to figure safe, let us take this on a straight-line basis at $5,600 per year. The present worth of $5,600 per year for 25 years is $78,500. The total cost would be therefore $140,000 + $78,500 = $218,500. The cost of cast-iron pipe will be about $6.50 per foot. It will have a life estimated at 80 years and the present worth of the depreciation for 25 years would be about $3,770. The total cost of pipe and depreciation will be therefore $260,000 + $3,770 = $263,770. The difference between this and the cost of the wood pipe is $45,270. If we take the capacity of the pipe as 8,000,000 gal. per 24 hours and the cost of pumping the water 150 ft. high as $20 per million gallons, the cost per million gallons per year would be $7,300. The present worth of $7,300 for 25 years at 5 per cent would be $102,500, so the present worth of $45,270, the difference in the cost of the two pipes, would be equivalent to a pumpage of 442,000 gal. per 24 hours.

During this whole period of 25 years, on account of tuberculation, the friction through a cast-iron pipe will average at least 40 per cent more than that of a wood pipe, corresponding to the increase of head from 150 to 210 ft., or to a reduction of the flow co-efficient to about 85 per cent of that of a new cast-iron or wood pipe. The cost of pumping through the cast-iron pipe will therefore be increased over pumping through the wood pipe from $20 to $28 per million gallons. The difference would be equivalent to pumping an additional 1,400,000 gal. per day through the wood pipe.

Therefore the permissible loss by leakage due to the difference in total investment would be 442,000 gal. per day, and due to the difference in cost of pumpage by tuberculation of the cast-iron pipe would be 1,400,000 gal. per day, making a total of 1,842,000 gal. per day. So if this calculation be correct, one could afford to pump 9,842,000 gal. through wood pipe to obtain a net quantity of 8,000,000 gal. per day, or 1,842,000 gal. per day (over 20 per cent) more than the pumpage through a cast-iron main, and still come out even financially so far as the cost of pumping and fixed charges is concerned. Hence it is seen that when compared with cast-iron the installation of a wood pipe in many important cases is justified from an economical standpoint.

Engineers sometimes are at a loss to know how much leakage it is permissible to use in the specifications for wood pipe and it must be confessed this is a difficult point to decide. Of course, every engineer wants to get as good results as is practicable without imposing upon the contractor undue hardships. Under very favorable conditions it may be possible to obtain results where the leakage will not be greater than 500 gal. per inch in diameter per mile, but the writer suspects that such low results are the exception rather than the rule.

With the best form of joint, pipe and quality of wood a very tight pipe can sometimes be secured. With the ordinary mortise-and-tenon joint under average conditions a considerable amount of leakage is almost unavoidable.

Summarizing, the relative advantages and disadvantages of the two pipes are as follows: Wood-stave pipe has a short life and generally a material leakage. It is low in cost and has a high co-efficient of discharge, and consequently small frictional resistance to the flowing water. Cast-iron pipe is high in cost and after a few years' use has a low co-efficient of discharge and high frictional resistance to flowing water. The leakage is usually negligible. It possesses a very long life and can be easily repaired in case of leakage. On account of the cheapness of wood-stave pipe a material amount of leakage is permissible from an economical standpoint, where the water so leaking can be spared and causes no damage to property.

Cost of Deleware's High Death Rate

Deaths in the State of Delaware in the last four years totaled 3,130 in excess of what would be expected "if Delaware had been up to the average for the country in health and sanitation," according to *Delaware Health News* (State Board of Health, Dover) for October. Assuming a value of $5,000 for each of 3,130 excess deaths the state suffered a loss of $15,650,000, besides an estimated total of $626,000 for nursing, medical care and funerals. The death records of Delaware have but recently been worked up in accordance with the standard system of classification. Chester H. Wells is special health commissioner, sanitary engineer and collaborating epidemiologist for Delaware and Dr. L. S. Connell is executive officer of the State Board of Health and registrar of vital statistics.

Capillary Siphoning of Water Through Soil

CAPILLARY action is capable of lifting water from a source of moisture and carrying it over a rise to discharge it on the other side at a point lower than its origin, according to experiments made by W. W. McLaughlin, senior irrigation engineer, Department of Agriculture, reported in the department's bulletin 835, just issued under the title "Capillary Movement of Soil Moisture." In the main series of experiments a trough or box 10 x 10 in. in cross-section and 10 to 20 ft. long, sloping downward at angles of 15 to 45 deg., and filled with earth, was supplied with water from a tank 4 in. below the bottom of the trough at its upper end, by a closed elbow or gooseneck, also 10 x 10 in. in section, whose lower end, closed with wire mesh, dipped into the water in the tank, the gooseneck being filled with earth in direct contact with that in the trough itself. The top of the trough was open, so that atmospheric pressure existed at all points of the free surface of the absorption water in the soil. In the cast of the 30 deg. trough, moisture drawn up from the tank by the soil in the gooseneck and traveling thence down the column of soil in the trough reached the lower end of the trough in 21 days, and after three or four days more dripped from the end as free water, no longer held by the capillary attraction. Moisture analyses of the soil indicated that at no point in the entire length of the earth mass, except perhaps at the extreme lower end, was the amount of moisture in the soil as great as that of capillary saturation. The experiment showed, in other words, that water could be raised from a body of free water by capillarity and delivered again as free water at a lower level, though transported by unsaturated soil.

In further exploration of this phenomenon, galvanized-iron tubes 7 x 7 in. in cross-sectional area curved to inverted U shape for use as siphons, were filled with soil and placed so that the short leg dipped into a tank of water and the long leg projected downward on the outside of the tank. The top of the horizontal leg of the siphon was open, so as to leave the soil exposed to the air at this point. The earth was retained in the tube by a sheet of fine-mesh gauze over the open end of the short leg, and by a complete closure of the long leg, just above which closure was attached a water-gage glass extending upward along the side of the tubes. The bend of the siphon was 8 in. above the water level of the tank, and the average width of the siphon at the top, center to center of legs, was 12 in. With the long leg of the siphon 6 ft. long below tank water level, sixty days' operation filled the gage glass up to a point within 11 in. of the surface of the water in the tank. Subsequent experiments with the same tube, using different soils, gave similar results, except that the experiments were not run for such a long period. Capillary siphoning was thus confirmed.

That the amount of water delivered is comparatively large was shown in one test of the trough type, as first described. After the water started dripping at the lower end, both the consumption of water from the tank and the discharge at the lower end were measured during a fixed period of time. The quantities were 18 and 8.78 liters respectively, so that the earth siphon delivered nearly half of the water that it took from the tank (the remainder presumably going to increase the saturation).

Special precautions were taken in some of the U-tube tests to guard against the formation of continuous capillary passages or "tubes" through the soil by puddling or other natural action. To this end ventilating pads or drainage wells of flat, compact packages of wire mesh were placed in the vertical part of the short leg, having the effect of ventilating the soil thoroughly. The presence of these pads did not affect the transmission of water, except that a little less water was picked up. In the most extreme case of ventilation the pads were so spaced that no part of the soil in the short leg of the siphon was more than 1½ in. from a pad.

Mr. McLaughlin concludes from his tests that capillary siphons may occur in nature and may in fact be common. Such siphons, he thinks, might cause the swamping of lands. He also suggests that capillary siphoning might develop in a reservoir embankment where the corewall does not extend to the top of the embankment, and the effect might be to saturate the earth on the downstream side.

Research Most Needed as Highway Construction Aid

IN SUPPORT of his contention that research and investigation must form a greater part of highway activities in the future, Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, made the following remarks in the course of a speech, Oct. 20, before the Land Grant College Association, which met at Springfield, Mass.:

For the next quarter of a century improvement of public highways will be the greatest single public activity. It will require such enormous sums of money that these expenditures should and must rest upon the soundest principles of engineering and economics.

There are many agencies interested in these problems. Their efforts should be correlated into one comprehensive program. It is highly important that, while this program should be pre-conceived as a whole, and each undertaking formed as a component part, the working out of the problems should go forward in such a manner that individual initiative will be encouraged and local conditions will be met. It must be recognized that while the improvement of highways in the aggregate is of national concern, and has been so recognized by the Federal government in making available large sums for encouraging road building, the important problems of research and investigations are more or less local. The underlying principles of sound construction or maintenance, or of economics, while remaining the same, are subject to an infinite number of variations dependent upon local conditions of topography, geological formations, population densities, development of industries and such modifying circumstances as to render necessary the proper solution of these problems through a decentralized organization. To bring such a movement into being on a national basis seems properly to be a function of the National Research Council.

Perhaps there is one master problem which should be solved first as a foundation for all others. This problem is that of highway traffic. We would be on a very much sounder basis now with reference to highway legislation, appropriations and organization were this investigation complete. The matter is of such importance as to demand a comprehensive and accurate study in every state and one which, first of all, well might engage the attention of those agencies which are interested in the fundamentals of knowledge necessary to the carrying out of large public undertakings. This problem has become acute in other countries. It is engaging the attention of both the English and French national departments of highways to the extent that detailed and accurate studies are being undertaken of highway traffic.

Filter Underdrain, Sand-Bed and Washwater Experience

Symposium on Current Practice and Operating Success with Various Details of Mechanical or Rapid Water Filtration Plants

[This article is the result of a questionnaire to operators and men intimately connected with 20 typical filter plants. The problems encountered in handling the sand, the medium which does the actual work at a filter plant, have been sought. Experience for 15 years with perforated-pipe underdrains indicates satisfactory service, and the first installment gives the details. Gravel depths seem to have increased to more than a foot in the best practice. Blow-ups, the bug-bear of the operator, are explained and instructions given as to how to prevent them. Mud balls have always existed in nearly all plants but the formation has not been generally understood nor have any but "strong-arm" methods been developed to remove them. How the man at the plant handles them is told succinctly. The second installment will be devoted to experience with various gutter designs, the relation to mud-ball formation, top sand scouring and sand-bed shrinkage.—EDITOR.]

Part I — Perforated-Pipe Underdrains — Gravel Depths—Blow-Ups—Mud Balls and Washing

MOST questions in filter design that were disputed points a dozen years ago should by now be sufficiently answered. In manufacturing, standard practice is desired as soon as possible so that factory methods may be developed and costs reduced. Have we reached that stage in the design of filters? If we have reached satisfactory perfection are we entering on a stage of non-development where the shelf-hardware type of filter may be ordered without detailed engineering design? Has a satisfactory underdrain system been developed? Do we surely know the proper depth and size of gravel layers? Can we control the "blow-up"? Are mud balls still a bug-bear? Have we yet developed a means of scouring the dirty sand at the top of the sand bed? Is gutter design well enough known so that we can get the high-rate wash expected? Do we still lose sand? Is the underwater shrinkage of sand beds well enough understood to apply a remedy? None of these questions relate to anything about a filter far removed from the medium which actually does the work. After all it is on the sand and its handling that reliance must be placed for efficient results. With this in mind an intensive experience study has been undertaken by sending a set of 16 questions relating to the above points to operators and men familiar with about 20 typical plants. The thirteen answers received are collated below:

Perforated-Pipe Underdrains

When the "Symposium on Underdrains" printed in the *Engineering Record*, May 9, 1914, p. 529, was prepared, perforated-pipe underdrains had not been long in use. There has now elapsed the 15-year period which the Harrisburg galvanized-iron pipes were expected to last and in several other plants the system has been adopted. The perforated-plate, ridge-and-valley type then so often employed is still in satisfactory use but the pipe system is so much cheaper and simpler that it is being used more and more. When screens to hold down the gravel are eliminated, deeper gravel layers used and air is replaced by a high-rate wash, any system which will provide sufficient loss of head to distribute the water evenly under the sand layer is satisfactory. As soon as a gravel layer was interposed over the openings in strainers, screen or pipe producing the loss of head no direct jet action on the sand grains was possible leaving only the loss-of-head function to the opening if, indeed, it ever really did serve any other.

Six men answered the two questions asked on perforated-pipe underdrains:

1. What has been your experience with the perforated-pipe type of underdrain?

2. Will it outlive its designed life? What is its present condition? How much more time is it good for? What were the alternatives?

W. G. Clark, consulting engineer, Toledo, O.—The perforated-pipe type has been installed in three plants recently built or revised under the direction of this office. So far they have given satisfactory service. This type has replaced cast-iron laterals and brass strainers in 34 filters at the Toledo plant. All of the laterals of this type which we have installed are provided with a single row of holes on the bottom. The laterals are set so as to give a 1-in. clearance over the filter floor. To avoid having the gravel blanket the openings in the laterals, the bottom layer is made up of gravel none of which is less than 1½ in. in diameter.

It is believed that the life of these laterals will be as great as that of the other parts of the filter equipment. So far as examinations have shown, the laterals are in satisfactory condition. Generally we have used Byer's wrought-iron pipe or cast-iron laterals. In one case we used wrought-iron pipe and after the laterals were made up they were "Sherardized," thus protecting them very fully from corrosion. At present we are installing in 22 new filters for the City of Toledo cast-iron laterals with a single row of holes on the under side, each pair being connected by a tee into a large concrete duct or main underdrain.

J. W. Ellms, consulting engineer and in charge of operation of Cleveland filters, Cleveland, O.—The writer's experience with the perforated-pipe system of underdrains for rapid sand filters has been more or less limited. The Division Ave. filtration plant at Cleveland is equipped with this type of underdrain and no trouble has been experienced with it during the 2½ years which it has been in operation. There has been no occasion to dig down into the beds in order to discover in what condition the pipes might be, and, therefore, it is impossible to state at this time what will be the probable life of the system.

Apparently some studies were made of other types of underdrains when designing this plant, such as the trough system with perforated brass plates and the nozzle systems. For the perforated-pipe system adopted, the specifications were quite carefully drawn. For example, the pipes were specified to be of cast-iron, drilled before being coated with a protective tar covering, leaded into the central manifold and properly held in place at their outer ends by a frame securely fastened to the floor of the tank. Moreover, any

openings that had become closed as a result of the dipping of the pipe into the tar mixture were opened carefully so that the metal edges should not become exposed.

Guy Eldredge, consulting chemist and bacteriologist, formerly in charge of operation, Fort Worth filters, Fort Worth, Tex.—Four new filter units of the Fort Worth plant are equipped with the perforated-pipe type of underdrain, but I have no further data. A 3,000,000-gal. plant constructed by the U. S. Army at St. Nazaire, France, was put in operation and operated by the writer for a little over six months. Two-inch galvanized pipe was used, laid 2 in. above a flat concrete floor. Perforations were as usual. The wash water distribution was good and no clogging or blow-outs occurred.

Prof. Charles Gilman Hyde, consulting engineer, Berkeley, Cal., (after consultation with staff of Filtration Division, Sacramento, Cal., C. G. Gillespie, resident engineer; H. B. Foster, assistant hydraulic and filtration engineer; H. N. Jenks, special assistant engineer; W. F. Langelier, special chemist and bacteriologist).—In addition to its use at Harrisburg, this type of underdrain has been employed in the Panama-Pacific exposition plant (1915) under the writer's design and in a small plant at the University of California by Mr. Foster. All of these experiences have been eminently satisfactory. The system is cheap, relatively, in construction, easy to install and it gives, under proper design, a most satisfactory distribution of both air and water without disturbance of the gravel. It has a long life and practically no maintenance costs.

At Harrisburg the filters were built in 1905 and placed in service late in that year. I have carefully reviewed all of the annual reports in which repairs and renewals are explicitly described and I find no reference to any trouble whatsoever with the underdrain system. No renewals have been necessary and no cost of maintenance has been incurred. It was expected that the pipe underdrains at Harrisburg would last at least fifteen years if of galvanized iron against a possibly greater life if made of copper. With fifteen years of life it was estimated to be cheaper to use galvanized iron than copper with, say, twenty-five years of life. Therefore, galvanized-iron pipes were employed with no treatment of the holes to prevent or delay corrosion. There is no evidence that the pipes require renewals and the distribution of air-and-water wash appears still to be perfect, as witnessed by the writer in December, 1919. No other type of underdrain was contemplated at Harrisburg. It would appear that a considerably greater life than fifteen years may be expected.

Mr. Jenks has made some notable experiments on pipe underdrains, 3, 3½ and 4 in. in diameter and 12 feet long. As a result of his convincing studies, it is proposed to use 3-in. standard wrought-iron pipes, 12 ft. long, net, between walls of the Sacramento filters. The pipes will be spaced 12 in. c. to c., with $\frac{7}{16}$-in. diameter holes on the underside 6 in. c. to c. The bottoms (outside) of the pipes will be placed 1 to 1.2 in. above the concrete floor. They will successfully handle all rates of water wash (through 18-in. depth of gravel in four layers) from 12-in. to 36-in. vertical rise per minute and will give perfect distribution of air applied at the rate of 4 cu.ft. per sq.ft. per minute.

Mr. Jenks' experiments demonstrate that with a 4-in. pipe, a length of at least 20 ft. can be successfully employed 12 in. c. to c., or possibly 16 in. c. to c., if an 18-in. gravel depth is used. In general his conclusions are: (a) That the holes may have a total area of 50 per cent of the cross-sectional area of the pipe, but not more than that. (b) That there may or should be from 0.3 to 0.4 sq.in. of hole area per sq.ft. of filter floor area. (c) That 3-in. pipes may be spaced as far apart as 12 in. c. to c. with holes 6 in. apart.

F. H. Waring, assistant engineer, Ohio State Board of Health—The department has been giving close study to the design of water filters proposed for use in this state, particularly for the last few years. It has been our practice to keep in close touch with the many plants in service about the state, noting the results obtained from the various types of designs in use. The first filter plant of fairly recent construction to adopt the Harrisburg perforated-pipe type of underdrain in Ohio is the one at Napoleon, placed in service in 1916. Four years' experience has demonstrated that this type has proved satisfactory.

A modification of the false bottom, cast-iron manifold and lateral type of underdrain was designed for the filters at Lima, by W. G. Clark, and placed in service in 1917. The wash water is admitted below the filter bottom in a concrete conduit extending across the center of the units and of such size as to limit the velocity of wash water to a low point, approximately 2½ ft. per second. Connecting with this conduit through the bottom of the filter are 3 x 2½-in. tees placed 6 in. c. to c., extending up above the floor of the filter and to which are connected 2½-in. laterals having ¼-in. holes 3-in. c. to c. on the under side.

R. S. Buzzell, chief chemist, Filter Plant, Flint, Mich.—Our strainers are of the type designed by the Pittsburg Filter & Manufacturing Co. type. They have given practically no trouble during the seven years in use.

Gravel Depths

Gravel depths have materially increased since the first thin layers were used at Little Falls, N. J. More and thicker grades have been added. Since the holding-down screens have been eliminated the depth in high-rate wash plants has been increased two or three times. With the perforated-pipe systems the practice of pointing the perforations downward has eliminated entirely any jet action which might cause shifting directly, but depths have increased just the same with the idea of obtaining a better distribution and less shifting. Twelve men answered the one question on this subject.

3. What are the gravel depths and grades finally found best suited to support the sand?

Charles P. Hoover, chemist, Columbus purification plant, Columbus, O.—We are at present rebuilding our filters and contemplate making some changes. The normal carbonates, calcium and magnesium with which a softening plant has to deal tend to incrust or form a coating on the sand. The holes in the strainer plates have become partly plugged with this incrustation, so that at the present time it is not possible to wash the filter with a vertical rise of more than 12 in. This rate of wash is not entirely satisfactory so we are taking out the strainer plates and drilling four ¼-in. holes through each plate. We expect to cover the strainer plates with 18 in. of gravel of the following grades:

5 in. between 2½ in. and 1½ in.
3 in. between 1½ in. and 1 in.
2 in. between 1 in. and ½ in.
2 in. between ½ in. and ¼ in.
1½ in. between ¼ in. and ⅛ in.
2½ in. fine pea gravel.

The depth of the sand will be 24 in. We are not going to buy regular filter sand but will use local bank sand.

Walter A. Sperry, chemist, filtration plant, Grand Rapids, Mich.—Originally our sands were supported on 8 in. of quartz gravel tied in between ridge blocks with a brass screen on top secured to the top of the ridge blocks. The gravel was supported on the strainer plates and consisted of the following:

3 in. between 1 in. and ½ in.
2 in. between ½ in. and ¼ in.
1½ in. between ¼ in. and $\frac{1}{16}$ in.
1½ in. between $\frac{1}{16}$ in. and No. 10 mesh screen.

Later, due to the problems introduced by after-deposits resulting from our lime-softening operations, we removed the screen and increased our gravel layers to a total thickness of 14 in. by filling in the space between the ridge blocks with gravel grading between 2 in. and 1 in. and adding gravel thereon as follows:

7.5 in. between 2 in. and 1 in.
1.3 in. between 1 in. and ½ in.
1.1 in. between ½ in. and ¼ in.
1.1 in. between ¼ in. and $\frac{1}{16}$ in.
3.0 in. between $\frac{1}{16}$ in. and No. 10 mesh screen.

This gave gravel layers that were not disturbed or displaced by the wash water when applied without the sand and has worked well for four or five years.

W. R. Gelston, superintendent, Water-Works Commission, Quincy, Ill.—My experience has all been with the New York-Continental-Jewel Filtration Co. strainer system. Our six filters, 12 x 34 ft. in area, are equipped with 9 in. of graded gravel and 30 in. of sand. We have had no trouble with mud balls but we do have trouble due to shifting of the gravel. When the air wash begins the filter breaks first immediately over the large pipe and seems to throw the gravel out of position and pile it up a short distance on each side of the large pipe.

Mr. Clark, Toledo—It is felt that approximately 17 in. of gravel is desirable. In the reconstruction of the Toledo filters, on account of limited depth, 15½ in. was used. This depth was made up of a 3½ in. layer under four 3-in. layers. Where a depth of 17 in. of gravel is possible we would use a 5-in. layer at the bottom and four 3-in. layers above it. Our experience indicates that the sizes given in the table below are satisfactory:

5 in. between 2½ in. and 1¼ in.
3 in. between 1¼ in. and ⅝ in.
3 in. between ⅝ in. and ⅜ in.
3 in. between ⅜ in. and ⅛ in.
3 in. between ⅛ in. and 10 mesh screen.

Lewis I. Birdsall, superintendent, Purification Division, Minneapolis, Minn. — After the screens installed in the twelve original Minneapolis filters were removed, the gravel in these filters was increased in size and depth as follows:

4 in. between 1½ in. and 1 in.
4 in. between 1 in. and ½ in.
2 in. between ½ in. and ⅜ in.
1¾ in. between ⅜ in. and ⅛ in.
1¾ in. between ⅛ in. and 10 mesh screen.

The twelve additional filters installed since 1914 have the following sizes and depths of gravel:

2¼ in. between 2 in. and 1½ in.
3 in. between 1½ in. and 1 in.
3 in. between 1 in. and ½ in.
2½ in. between ½ in. and ⅜ in.
2 in. between ⅜ in. and ⅛ in.
2 in. between ⅛ in. and 10 mesh screen.

The 15 in. of gravel graded as above permits of a vertical rise of wash water of 24 in. per minute without displacement of the gravel and has been entirely satisfactory.

Mr. Ellms, Cleveland—The depth of the gravel layer in the Division Ave. plant is 22 in., of which about 16 in. lie above the center of the lateral pipes. The bed is well graded from coarse to fine as regards its gravel, and properly supports the sand bed. The sand bed is about 27 in. deep and is rather coarse (0.45-mm. effective size) for the most effective filtration.

It is the writer's belief that where the high velocity method of washing is used the character of the gravel bed is of the greatest importance. Not only must the bed be of the right depth, but also it must be uniformly graded from coarse to fine. The gravel in upper layers should be only a little larger than the coarsest portion of the sand. The ideal filter bed consists of as nearly as possible uniformly decreasing sizes of gravel and sand. The gravel bed is a distributor for the wash water after leaving the strainer system, and its importance in this respect cannot be too strongly emphasized.

For safety and for the best effects it is believed that between 12 and 18 in. of properly graded gravel will generally be found satisfactory. The writer has operated a large sand filter bed successfully with only 8 in. of gravel, and failed to observe any marked difference between the efficiency of washing of this bed and those which contained 14 in. of gravel. Nevertheless, as a factor of safety, it is thought that at least 12 in. of graded gravel should intervene between the strainer system and the sand bed.

Mr. Eldredge, Fort Worth—A gravel depth of about 10 in., graded as follows, is used:

2-3 in. between 1½ in. and ¾ in.
3-4 in. between ¾ in. and ⅜ in.
remainder between ⅜ in. and ⅛ in.

Prof. Hyde, Berkeley—At Harrisburg only 7 in. of gravel was employed. A 4-in. layer around and just above the pipes, of ¾ in. to ½ in. gravel; a second layer of 3-in. depth, ½ in. to ¼ in. gravel. This depth at Harrisburg seems to be satisfactory with a water-wash rate of from 9 to 12 in. vertical rise per minute and an air-wash rate of 2.5 cu.ft. per sq.ft. per minute, but with greater rates of wash, more layers and greater depths of gravel underdrains should be used.

W. H. Lovejoy, superintendent filtration, Louisville Water Co., Louisville, Ky. — Two different depths of gravel are used. In the old battery of filters we had originally 7 in. of gravel resting on brass strainer plates between concrete ridge blocks, the gravel being held down by a 10-mesh brass screen. This screen rotted out after about eight years' service and we then removed the screen and rebuilt the gravel bed to a depth of 11 in. This new gravel bed is carefully laid in four layers:

4 in. between 1½ in. and ¾ in.
3 in. between ¾ in. and ⅜ in.
2 in. between ⅜ in. and ⅛ in.
2 in. between ⅛ in. and 10 mesh screen.

A thicker bed of gravel was preferred here but we were limited to 11 in. by the filter wall height.

In our new battery of filters we have the Pittsburgh strainer cups set in concrete and overlaid with 14 in. of gravel made up as follows:

5 in. between 1½ in. and ¾ in.
4 in. between ¾ in. and ⅜ in.
3 in. between ⅜ in. and ⅛ in.
2 in. between ⅛ in. 10 mesh gravel.

I have found that 14 in. of gravel properly graded is nearer the optimum depth than is 11 in.

Mr. Waring, Ohio State Board of Health—A high rate of wash water, say 15 gal. per sq.ft. per minute, is desired, and without the use of air agitation of the sand in filter washing.

The use of a carefully graded gravel to assist in the distribution and in breaking up jet action from several types of underdrain distribution is needed. We feel that the size of gravel should preferably be graded from 2 in. at the largest to at least ½ in. for the smallest size and that the whole depth of gravel should be about 18 in. as a minimum.

It has also been demonstrated that the use of torpedo sand in addition to the gravel, or the use of a coarser sand, to support the filtering sand, is advisable. If the latter is employed, about 12 in. should suffice. This idea has been developed for the most part at the Akron filter plant under J. S. Gettrust. The filtering sand should be limited in size between 0.35-mm. and 0.40-mm. effective size, the uniformity coefficient not to exceed 1.7.

The whole depth of the filter sand should amount to about 30 in. and the distance from the top of the sand to the top of the wash-water troughs should be held to about 27 in.

Mr. Buzzell, Flint, Mich. — Ten inches of gravel seems to give satisfactory results. We are of the opinion that a 4-in. layer of finest gravel is necessary to support the sand.

S. T. Powell, chemist, Baltimore County Water & Electric Co.—In three plants recently designed the following grading has been entirely satisfactory:

6 in. between 2 in. and 1¼ in.
4 in. between 1¼ in. and ¾ in.
4 in. between ¾ in. and ¼ in.

Recently in removing the filter medium from a 500,000-gal. plant which had an 8-in. gravel bed the gravel was found displaced and piled up in one portion of the bed to a depth of 20 in. In another area sand only remained, packed around the strainers. The condition was attributed entirely to the grading and depth of the gravel.

Blow Ups

In the early use of strainer plates much difficulty was encountered with blow-ups, due largely to insufficient strength in the holding-down arrangements.

Blow-ups occur also in other types due to unequal compacting of the sand bed, uneven distribution of wash water and unusual accumulations of clay in certain areas. Most of the mechanical defects have been eliminated. The use of monel metal holding-down bolts solved the difficulty at Evanston, while the design has been changed considerably at Minneapolis. Nine men answered the two questions relating to blow-ups.

4. When blow-ups have occurred, what has been the cause; air, water, valve manipulation or an attempt to use air and water together?

5. Have repairs been replacements or new designs and what?

Mr. Sperry, Grand Rapids—There have been no blow-ups at this plant. In the beginning there were some few failures of the filter bottoms due either to the breaking of bolts or to the failure of the concrete blocks. These occasions were few in number and in no way serious. After these weak spots were found and corrected, they never recurred. Considering the total number of plates and blocks we have always felt that we had a surprisingly small share of this type of failure. With the exception of the removal of the screen noted above all repairs have been small in extent.

Mr. Clark, Toledo—In the Toledo plant in 1915 a number of blow-ups occurred due to the softening or deterioration of the cast-iron laterals at the points where the brass strainers were screwed in. These defects were so numerous and were appearing so frequently that complete revision of the underdrain system was decided upon. We have experienced no other trouble from blow-ups due to other than improper valve manipulations on the wash-water supply. We have not attempted to use air and water together except where a separate air system is provided. This air system being located just above the gravel does not cause blow-ups. The only extensive repairs in the Toledo plant have been where cast-iron laterals with brass strainers were replaced by wrought-iron laterals.

Mr. Birdsall, Minneapolis — Blow-ups in the filters have been caused entirely by failure of strainer plates and bolts of Tobin bronze, due to cold working of the metal. Annealing after bending or working was necessary. Monel metal gave no difficulty. (See *Journal* American Water Works Association, Dec., 1917, p. 471).

Replacements were made at first, followed by a change in design. Monel metal plates and bolts have been used in all new filters constructed. Cast-iron plates were placed along the side of the ridge blocks to serve as shoulders on which the strainer plates rest. The ridge blocks were made continuous across the entire width of each half of the filters, there being no center passage longitudinally of the filters beneath the strainer plates. Three-inch riser pipes in manifold form were substituted in place of the four 14-in. riser pipes in the original installation. Two 3-in. riser pipes serve as the collecting system for the area between each pair of ridge blocks in each half of the filter.

Mr. Buzzell, Flint, Mich.—While we have never had any trouble due to blow-ups, yet any tendency seems to come from the use of the air and water wash together.

Mr. Powell, Baltimore Co. — In every instance where blow-ups have been observed they have been due to excessive air pressure or to the simultaneous application of water and air. The reckless use of air by the operator is the most serious objection to air agitation of sand beds. Consequently, in small installations where the method of cleaning cannot be carefully controlled the writer believes that a high velocity wash is preferable to air and water.

Mr. Ellms, Cleveland—No difficulties with blow-ups have been experienced with the perforated-pipe type of strainer system. The washing rates used are from 27 to 29 in. per minute. The opening of the hydraulic valve on the wash water line has been carefully adjusted on each filter so that the above rate of washing cannot be exceeded. It is customary to open the wash-water valve slightly at the beginning of the wash and to hold it in this position for about one minute. The valve is then opened the remaining distance for which it is adjusted for the balance of the period of the wash, or from 2 to 2½ min. longer. Under these conditions the pipe system is subjected to a minimum shock, and the sand bed is uniformly lifted and washed. It is believed that a well-constructed, perforated-pipe system would be able to withstand a much more violent shock than that to which it may be properly subjected when carefully and intelligently handled. In other words, it offers an ample factor of safety against improper handling.

Mr. Eldredge, Ft. Worth—Blow-ups have occurred with the old cast-iron manifold. In most instances it was due to blowing out of one or more strainers. In one instance, however, it was due to a cracked manifold and this in turn was caused by the settling of the filter floor. No trouble has been experienced with air blow-ups except where the separate air-and-water systems are in use. In such systems I have found air pipes split or worked out of the air manifold. In one plant gaskets were blown out of the joints of the large air manifold. On air-locked filters improper valve manipulation will generally cause blow-ups of rather a serious nature.

With a cast-iron manifold, repairs have consisted of bushing the strainer holes and welding breaks in the main header. No replacements have been made.

Prof. Hyde, Berkeley—There is no evidence of any difficulty from blow-ups or any other causes at Harrisburg, so far as my observation goes, and no repairs have been necessary.

Mr. Lovejoy, Louisville—No air is used and all of our blow-ups have been due, in the old units, with ridge block underdrains, to broken anchor bolts which allowed the strainer plate to drop down. In the new units, with the Pittsburgh strainers, the blow-ups have always been due to the blowing-off of the strainer cups which probably had never been screwed down tightly enough.

When we rebuilt the gravel bed in our old units, we took this opportunity of replacing all of the ¼-in. strainer-plate anchor bolts with ⅜-in. rolled brass bolts, as we found that most of the old ¼-in. brass bolts were badly eaten and crystallized and would break easily.

Mud Balls and Washing

Just why some kinds of turbidity are more prejudicial to mud-ball formation than others has never been explained. The colloidal theory, so much discussed latterly by the chemists, probably can be applied but improper coagulation, short settlement, insufficient washing and lack of sand scouring all are factors. Eleven men had answers for the four mud-ball questions.

6. Has the top of the sand always kept clean?

7. Have mud balls formed? How are they prevented and removed?

8. Is there a relation between mud-ball formation and rate of wash, or is the formation due to the type of turbidity?

9. Is the horizontal distance that the dirty wash water must travel a definable factor in the formation of mud balls?

Mr. Sperry, Grand Rapids—Our top sand is not clean and we do have mud balls and mud coatings. The condition is local and is caused by the special feature of the lime softening. It occasions us little trouble and does not appear to interfere with the proper functioning of the filters either in the way of clarifying the water or in removing the bacteria. Removal of mud balls is effected by scraping and washing with a second or third scraping as seems necessary two or three times a year.

There is not so much relation of the formation of mud balls to the wash as to the character of the raw water received on the surface of the filters. There is no evidence locally that the horizontal travel of the wash water is a factor. The Grand Rapids filters have troughs spaced 6 ft. c. to c. The troughs are 21 in. wide and the bottom is

V-shaped below vertical sides. It has a fall of 6 in. in 10 ft. toward the central channel into which the troughs discharge. The total depth of the gutter from the outside top to bottom is 18 in. at the back and 24 in. at the connection with the central channel. The filter sand is just high enough to dip into the bottom of the trough at the channel side.

Mr. Clark, Toledo—At times, especially when softening was being done, it has been difficult to keep the top of the sand clean. This has been due in part to deposits containing a considerable percentage of magnesium hydrate. It was found that these deposits were not removed satisfactorily by the use of a wash of approximately 22 in. vertical rise unless air was used.

When the use of air was discontinued mud balls began to form but by the use of air their formation was stopped and the muddy condition of the top of the sand was overcome.

It has been found at the Toledo plant that a relatively high rate of wash is necessary to avoid the formation of mud balls when softening is being done. As low a rate of wash as 12 in. with the use of air has prevented the formation of mud balls.

It is not believed that the distance between wash water troughs is definitely related to the formation of mud balls but it is believed that this distance effects the amount of wash water required to wash the filter properly.

Mr. Buzzell, Flint, Mich.—At certain times of the year it has been necessary to scrape off some foreign material from the sand surface. Mud balls occur at times. When found forming, a strong wash and the operation of running a rake through the bed tends to eliminate them. If mud balls are still present they are usually small, settle on the surface and are scraped off with a trowel. Mud-ball formations here seems to be due to a colloidal type of turbidity. Their formation may be related in a measure to the horizontal distance that the dirty wash water must travel.

Mr. Powell, Baltimore Co.—Mud balls or mud accumulations have occurred on the surface of the sand in every mechanical filter installation that has come under my observation. In some instances these accumulations have formed very slowly and in others rapidly. Accumulation of mud on the surface is caused by no single element, but is the resultant of one or all of the following conditions: (1) Poor distribution of wash water, either from an improper placing of the strainers or from a failure of the wash water distribution system while in service. (2) Too great horizontal flow of the dirty wash water before discharging into the wash water gutter. (3) Insufficient capacity of the wash water trough to carry away the washings. (4) Too short a period of detention of the coagulated water, thereby requiring the bed to receive an excessive amount of suspended matter that has not been completely entrained by the coagulant. (5) Character of the turbidity and suspended matter in the raw water.

By proper design and efficient operation of a filter installation the first four conditions mentioned above can be corrected. The last condition is difficult to correct, if not beyond the control of the engineer. It is for this last reason that so many well designed and efficiently operated systems are confronted by this problem. Mud balls are more prevalent when the raw water carries a high amount of turbidity and suspended matter, either continuously or after storms, and when the particles of suspended matter have a tendency to adhere. Many clays possess this agglomerating characteristic.

It has been the practice of the writer to have the operation of the plants under his supervision drain the plants after they have been thoroughly washed and scrape the mud accumulations from the surface of the sand. After each scraping the filters are again washed and the operation repeated if the mud balls are still present. Frequently it is necessary to repeat this operation three or four times to eliminate the deposits entirely. The filters are inspected every few weeks and are scraped whenever there are any excessive areas of mud balls over the beds. This method is not applicable to large installations but has been followed successfully in a number of small plants for many years.

Mr. Birdsall, Minneapolis—Occasional scraping of the filters is necessary to remove the fine sand and also surface accumulations that do not wash off.

Very little trouble is experienced with mud balls because filters are scraped often enough to prevent their formation. Turbidity at Minneapolis is so slight as not to be a factor in the formation of mud balls. I believe that the rate of wash is a factor in the formation of mud balls as is also the lateral travel between the wash-water troughs. A rate of wash water greater than 18 in. vertical rise per minute is not used in our old filters because we fear that the Tobin bronze strainer plates and bolts may fail. A vertical rise of 24 in. per minute is safely used in the eight new filters having monel metal plates and bolts constructed in 1919. There is very little tendency for mud balls to form in the new filters.

C. M. Daily, engineer in charge, Supply and Purification Section, St. Louis, Mo.—If the filter is washed until the water is clear the distance between gutters will have no effect on the formation of mud balls, but the farther the gutters are apart the more wash water will be required.

Mr. Ellms, Cleveland—The writer has never had any experience with the formation of mud balls in sand filter beds. It is his belief, however, that where they do form the cause lies chiefly in inefficient and imperfect washing, and in the character of the organic and inorganic matter in the water being filtered. It is, therefore, quite possible that primarily the trouble may originate in an improperly designed strainer system and a poorly graded and laid gravel bed.

Mr. Eldredge, Ft. Worth—The top of the sand has not always kept clean. Mud balls have formed. Prevention was sometimes impossible with the old plant. The settling capacity was limited to three hours and the rate of filtration was high with a very turbid water. Removal was accomplished by screening by hand. The horizontal distance the dirty wash water must travel is a definable factor in the formation of mud balls.

There is a relation between mud-ball formation and rate of wash, but the type of turbidity I regard as the main factor in mud-ball formation. Nearly every operator that I have talked to regarding plant operation has reported mud balls forming at certain seasons. The rate of wash, etc., being in these instances a constant factor.

Prof. Hyde, Berkeley — At Harrisburg there has been no difficulty from unclean sand or mud balls.

At Camp Meade, Md., where, in essence this type of underdrain was used in the Roberts' wooden tank filters, great difficulty with mud balls has been experienced. This plant has a high-rate (22 to 24 in.) water wash and no air. Mud balls may have been due to insufficient coagulation (during the period July-November, 1918), to the too-great distance for the water to travel to the troughs and perhaps they may have been due to the character of the water and the contained turbidity.

Under the conditions obtaining while I was camp sanitary engineer (August-November, 1918) there was no apparent way of preventing the formation of these mud balls. The top sand was removed from time to time and washed in a box. A wire screen skimmer on a long handle was employed but without satisfactory results. From time to time the filters were partially drained and the surface scraped with a shovel. From one-fifth to one-third of the sand surfaces in the tanks were frequently found to be coated with mud in small round balls or particles.

At Camp Meade these mud balls formed in spite of what would seem to be a sufficiently high rate of wash (22 to 24 in. vertically per minute). Prof. Langelier suggests that the trouble may be due to poor or insufficient coagulation and this explanation seems to be reasonable. It is also reasonable to suppose that the amount and character of the turbidity has something to do with it. A too-great distance between troughs may be a factor. The Camp Meade plant operated while I was there under all these difficulties. From the center of the tank a small amount of wash water had to travel about 6 ft. 8 in. to the circular gutters on the side

walls, but the major portion of the water traveled less than 4 ft. to the gutters.

Mr. Lovejoy, Louisville—The top of the sand has not always kept clean. Sometimes during the summer for short periods the top layer of 2 or 3 in. of sand shows a dark discoloration which I have always ascribed to organic matter.

We have had frequent occurrences of mud balls. During the summer in the presence of algae we have what might be better termed "sand balls." That is, during washing the sand rolls up into balls of various sizes, being held together firmly by the gelatinous coating of micro-organisms. During other times of the year we have plain mud balls with little or no sand inter-mixed. Both of these types are practically unpreventable by any means so far known. Of course, the sand balls break up and disappear as soon as the micro-organisms die off. The mud balls gradually disappear as the type of turbidity which causes them disappears.

We have tried several means of removing the mud balls, such as raking, scraping and dragging a screen over the sand while washing, but all of these means are slow, laborious and not very effective.

I believe there is more of a relation between mud-ball formation and a certain type of turbidity than with the rate of wash. The mud balls are so heavy that a washing rate that will lift them will also carry away sand.

If the horizontal distance of travel of dirty wash water is so great that this heavy type of mud is not all removed at each washing, then there will be a gradual accumulation that will eventually form mud balls. We have had this exemplified in an extreme way recently. One of our filters was out of service all winter with the inlet valve open, so that the unfiltered water of varying turbidities had access to it for several months. The gradual accumulation of mud that settled on the sand of this filter was found to be ½ in. thick in a solid layer. Four successive washings at increased pressure did no more than break the mud into large lumps that finally had to be shoveled off.

Mr. Waring, Ohio State Board of Health — The wash-water troughs should be of sufficient number to permit of a maximum travel of suspended particles in washing of about 30 in.

(To Be Continued)

Miles-Acid Process Applied to Tannery Wastes

Experiments by E. S. Dorr, engineer of sewer service, Boston, Mass., with the Miles-acid process on heavy tannery wastes indicate that a clear liquid could be obtained in five minutes and a well-settled sludge in half an hour. Mr. Dorr gave this information and that following in a paper presented recently to the American Society for Municipal Improvements. The dark blackish-red color of the tannery wastes was bleached to straw color, the odor completely killed and organic and volatile matter, including suspended solids, was reduced 50 per cent. The SO_2 used was at the rate of 7,167 lb. per million gallons which precipitated 4 tons of sludge (dry) having a grease content of 16.88 per cent. The ammonia content of the sludge was 7.5 per cent before and 9 per cent after degreasing. The total degreased sludge was 6,640 lb. containing 1,360 lb. grease. At present prices the 9 per cent ammonia fertilizer would be worth $67.50 per ton or $222.75 for 3.3 tons, the amount of fertilizer material per million gallons. With grease at 5c. the total value of grease and fertilizer would be $290.75; at 8c. it would be $331.55 per million gallons treated. On the New Haven basis (see *Engineering News-Record*, Dec. 5, 1918, p. 1034, and Jan. 2, 1919, p. 32) the cost of treating the tannery wastes experimented with would be $161.22 per million gallons, leaving a substantial profit, whereas at present Mr. Dorr stated that he is aware of no place where the sludge is not a burden of expense for disposal.

Hydraulic Sluicing for Ochoco Dam in Heavy Material

Preponderance of Rock Governed Method Used on Oregon Irrigation Dam—Water and Power Needs, Quantities and Costs

SLUICING material into the recently completed Ochoco dam near Prineville, Oregon, had to be done with limited power and water, working in material of which a large percentage was rock or hardpan. The difficulties were such that the general contractor abandoned the job in February, 1919, and the irrigation district for which the work was being done then arranged with the sub-contractors to take charge and complete the work.

Prospecting on both sides of the stream indicated that the north side was the more favorable source of material and work was concentrated there. However, even then the hard formation was found so well distributed over the available area that sluicing was slow and costly from the start. Beds of good material were known to exist beyond the hard formation but in order to keep the flume down to a grade that would reach them it was often necessary to blast out a channel. In several cases solid rock cuts through ledges were blasted to a depth of 25 ft. The formation was so irregular that it was finally decided to simply cut into the bank with the giant, working in the general direction of the good material.

GIANT IN OPERATION—NOTE ROCK CUT 25 FT. DEEP

The usual procedure was to wash down a bank with the giant until only a talus of large rock fragments or a ledge of solid rock remained. Then the giant operators would move to other points while the powder

crew shot the ledges or the larger masses of rock forming the talus. Crews of men by bulldozing and with sledges broke up the larger sizes for the next attack of the giant. By using four giants set up on as many spurs of the pressure pipe line, several separate headings were kept open. Thus crews went from one heading to another, and continuous operation as well as the fullest use of the limited power available was maintained. In fact, the operation of the pumps was practically continuous, averaging month after month between twenty-three and twenty-four hours per day. This was an important factor in the work as the power company limited the energy consumption to 450 hp. at any one time.

For several months the primary purpose of the work was to get the flumes through hard material on the gradient necessary to insure the desired quantity of sluicable earth. During this time material was continuously being sluiced into the dam but not under most ideal conditions. When the flume had been extended on the low elevations to such a distance as to assure tapping sufficient good material to complete the work, the policy was changed and attention was concentrated on avoiding the heavy rock ledges and choosing a line of advance through material carrying the greatest percentage of fines.

The determining factor in the yardage delivered to the dam each month was not the time consumed in blasting and sledging out rock on talus slopes, but rather the material-bearing capacity of the water. Where a large percentage of rock fragments was being handled, the capacity was found to vary directly with the quantity of fines in the water, that is, the more fine material in suspension, the greater the amount of rock which a given quantity of water would carry down the flume. Ultimately, but not until the work was well on toward completion, the flume lines were carried to points where the operators could secure that mixture of broken rock and fines which would carry the largest possible quantity of spoil.

Taking the job as a whole and despite the difficulties, an average of 6.2 per cent of spoil was carried in the water during the year 1919. The cost during this time averaged 75c. per cubic yard. The itemized allotment of this total was as follows:

Power	7 027
Installation and breakout	5 286
Lumber	3 844
Repairs, hardware and tools	3 225
Powder	5 575
Office and general expense	1 447
Rents of plant	7 814
Labor	34 161
Compensation (10%)	6 840
Total	75 219

The excessive proportion of rocky fragments moved not only greatly increased the powder cost, but materially affected the labor cost because of the large crew constantly employed in breaking boulders and the hard formation. The rental included two complete pumping outfits so that the available power could be utilized continuously in case of trouble or breakdown. It also included several thousand feet of wood-stave pipe of various dimensions and other sluicing equipment necessary to maintain the several headings ready for immediate use. Most of the items are estimated as having been two to three times what they would have been before the war. The total volume sluiced was 527,000 cu.yd. The total material placed in the dam, including that deposited from the spillway excavation, was 540,000 cu.yd.

RECORD OF SLUICING OPERATIONS ON OCHOCO DAM BY MONTHS FOR 1919

	Feb.	March	April	May	June	July	August	September	October	November	December
Total hours working giant	223	611	597	293	264	595	671	653	659	637	151
Average giant hours per day		19	19	16	12	21	23	23	22	23	5
Average gal. per day's run	1,572,471	2,821,480	2,861,666	2,272,222	1,695,770	3,347,846	3,952,330	3,732,856	3,448,015	3,204,552	1,000,000
Average load in flume water	8%	9%	8%	7.3%	6%	6%	6%	6%	6%	6%	6%
Total yardage	13,209	38,467	35,333	14,442	10,500	28,067	34,260	32,144	27,177	28,901	7,400
Average yardage	629	1,241	1,177	802	500	1,002	1,181	1,148	937	1,070	740
Average horsepower	394	401	419	440	414	412	382	378	377	377	422

The sub-contractors, who later became the general contractors and carried the work to completion, were the sluicing department of the Puget Sound Bridge & Dredging Co., of Seattle, formerly Lewis, Wiley & Morse, Inc., R. W. Rea is project engineer for the district and J. M. Howells is consulting engineer.

Water Solubility a Necessary Property of Wood Preservatives

ANY substance to be an effective wood preservative must be soluble in water at least to the extent of producing a toxic water solution. By a theory now being developed at the U. S. Forest Products Laboratory (explained below) it would seem reasonable to expect that any material which is poisonous enough to kill an organism of any kind must necessarily be soluble in the body fluids of that organism; and the chief body fluid of timber-destroying fungi and wood borers is water. With very poisonous materials this solubility need not be great. In fact, 1 part in 1,000,000 may be sufficient if the material is poisonous enough.

Wood preservatives now in use are of two distinct types—inorganic salts, such as zinc chloride, which are very soluble in water; and oils, such as creosotes, which are generally considered to be insoluble. The solubility of creosote is usually considered so slight as to be neglected, but experiments indicate that certain constituents of creosote are sufficiently soluble in water to make it poisonous for wood destroyers. Creosote oil may, therefore, be considered as consisting of two groups of compounds, one of these being sufficiently soluble in water to render it toxic; the other insoluble in water and hence not toxic. The non-toxic oils act as a reservoir for the toxic oils and feed them slowly to the moisture in the wood.

The difference between oil preservatives and inorganic salt preservatives, as far as this theory is concerned, is in their method of retaining the reserve supply of poison. Zinc chloride has no reserve supply, all the material being soluble in the usual amount of moisture present in air-dry wood. Sodium fluoride may have a reserve supply in the form of solid crystals, if applied in a saturated solution. Creosote oil may have a considerable reserve supply stored in the oil itself, this supply being fed to the wood as needed.

Various Schedules of Fees for Consulting Engineers

Compiled by Edmund I. Mitchell, Assistant Secretary of Committee on Classification and Compensation of Engineers, Engineering Council, New York City, with aid of Engineering Societies' Library.

VARIOUS suggestions as to proper fees for engineering services have been put forth by individual practitioners and by the American Institute of Consulting Engineers (1911), the Connecticut Society of Civil Engineers (1914), the Iowa Engineering Society (1917) and the Mahoning Valley (Ohio) Engineers (1918), for the guidance of both the engineer and his client. The American Institute of Architects also has a schedule of minimum charges (revised 1908). So far as can be determined, however, the four national societies representing civil, mining, mechanical and electrical engineering have never given consideration to this question.

An examination of technical periodicals published during the past decade shows that these schedules make provision for three methods of charging: (A) A percentage of the cost of the completed project; (B) A per diem rate; and (C) A fixed sum. Suggested minimum charges are as follows:

A. PERCENTAGE OF COST OF WORK

American Institute of Consulting Engineers (1911); Connecticut Society of Civil Engineers (1914); Iowa Engineering Society (1917)—(1) For preliminary conferences, studies, estimates and reports: A. I. C. E., 1.5 to 3.0 per cent; Ct. S. C. E., 1.0 to 1.5 per cent; I. E. S., 1.5 per cent.

(2) For services as in (1) and in addition preparation of drawings, specifications, contracts and all work to the letting of the contract: A. I. C. E., 2.5 to 5.0 per cent; Ct. S. C. E., 2.5 to 5.0 per cent; I. E. S., 2.5 per cent.

(3) For services as in (2) and in addition advice in letting contract and general supervision of construction: A. I. C. E., 4.0 to 5.0 per cent; Ct. S. C. E., 4.0 to 8.0 per cent; I. E. S., 5.0 per cent.

(4) For full professional services including complete supervision and inspection of construction: A. I. C. E., 6.0 to 10.0 per cent; Ct. S. C. E., 6.0 to 12.0 per cent; I. E. S., 6.0 per cent.

Mahoning Valley (Ohio) Engineers (1918)—(1) For engineering and supervision for sewer district or system, or disposal plant, per diem rate shall apply when cost of work is less than $3,000: For first $15,000, 8.0 per cent; for second $15,000, 7.5 per cent.

(2) For engineering and supervision on paving work, per diem rate shall apply when cost of work is less than $3,000: For first $15,000, 7.0 per cent; for second $15,000, 6.5 per cent.

Committee of Engineers' Society of St. Paul (1918)—(1) For preparation of preliminary report with a general plan and an estimate of cost, 0.75 per cent of estimated cost but not less than $150.

(2) For complete plans and specifications including preliminary report and survey but exclusive of soundings and borings: Cost of work under $10,000, 3.5 per cent; under $25,000, 3.0 per cent; under $50,000, 2.5 per cent.

Consulting superintendence 2.5 per cent. Number of trips to the work to be stated in contract; per diem rate plus expenses to apply to trips in excess of stipulated number. Extra charges for engaging resident engineer, making alterations after plans have been approved, etc.

Under all these schedules in the preliminary stages cost of work is based on the estimated cost; later, on cost of all labor and materials necessary to complete work plus contractor's profit and expenses.

B. PER DIEM RATE

American Institute of Consulting Engineers—Charges for consultations, reports and opinions should vary according to the character, magnitude and importance of the work or subject involved, and according to the experience and reputation of the individual engineer from $100 per day up. For expert testimony, etc., a retainer from $250 to $1,000 and up should be charged. These charges are exclusive of expenses and of charges for assistants. Six hours of actual work constitutes a day, except that when engineer is called from office 24 hours or fraction thereof shall constitute a day.

Connecticut Society of Civil Engineers—(1) For expert services, reports, consultations, expert testimony, etc., $25 to $100.

(2) In consulting capacity on designs and for more ordinary services, examinations, reports, etc., $15 to $50.

Additional charges for actual expenses and for assistants. Seven hours actual work constitutes a day.

Iowa Engineering Society—(1) For consultations, opinions, expert testimony, preliminary investigations and preliminary reports, $25.

(2) In consulting capacity on design or for services covering a greater period than for one day, $25 per day.

(3) For examinations or reports of a more extensive nature, $15 per day. Seven hours constitute a day, except that when engineer is called from office 24 hours or fraction thereof shall constitute a day.

Mahoning Valley Engineers—(1) For consultation, opinion, testimony, preliminary investigation, reports and in consulting capacity upon design, $25.

(2) For extensive examinations or reports covering several days, $15 per day.

Minimum charge for field work, $10 per day.

Charges for assistants as follows: Engineer in charge of field work, $10; instrumentman, $5; rodman, chainman, $3.50; inspector on paving and sewer work, etc., $3.50.

In addition to above charges, a charge to cover actual expenses. Seven hours constitutes a day except that when engineer is called from office 24 hours or fraction thereof shall constitute a day.

C. FIXED SUM

American Institute of Consulting Engineers—May include all items cited under per diem rate.

Connecticut Society of Civil Engineers—Iowa Engineering Society—(1) Fixed sum covering all charges.

(2) Fixed sum covering services only, with additional charge for expenses, both personal and for assistants.

Contracts should set a time limit within which work should be completed, and should contain clauses protecting engineer against unforeseen contingencies, alterations, etc.

These schedules also authorize special charges for difficult and unusual work, at correspondingly higher rates.

Based on bookeeping costs wherein are represented proper profits, overheads, cost of getting business and all legitimate general expenses, W. L. Benham suggests (1920) the following Fee Schedule for Consulting Engineers in the Kansas City District:

A. PERCENTAGE OF COST OF WORK

For Municipal and Valuation Work—(1) Preliminary investigations, report and estimate: $50,000 to $100,000, 1.5 per cent; $101,000 to $500,000, 1 per cent; $501,000 to $1,000,000, 0.75; $1,000,000 and upward, 0.5 per cent.

(2) Plans, specifications, estimates, attending to letting contracts and final inspections and tests: $50,000 to $100,000, 3.5 per cent; $101,000 to $500,000, 3 per cent; $501,000 to $1,000,000, 2.75 per cent; $1,000,000 and upward, 2.5 per cent.

(3) Supervision of construction:

$50,000 to $100,000, 2.5 per cent or $250 to $300 per month for each man furnished and an extra fee of $25 per day plus expenses when called from office for inspection.

$101,000 to $500,000, 2 per cent or same monthly charge per man and an extra fee of $35 per day plus expenses when called from office for inspection.

$501,000 to $1,000,000, 1.5 per cent or same monthly charge per man and an extra fee of $50 per day plus expenses when called from office for inspection.

$1,000,000 and upward, no fixed sum or percentage but same monthly and daily charge as for preceding class of work.

(4) Appraisals, including testimony or investigations:

$50,000 to $100,000, 3 per cent or $75 per day and expenses up to $300, and $50 per day thereafter. Minimum fee, $1,000. Each man furnished at cost plus 50 per cent.

$101,000 to $500,000, 2 per cent or same as above.

$501,000 to $1,000,000, 2 per cent or $100 per day plus expenses up to $5,000 and $75 per day thereafter. Minimum fee, $2,500. Each man furnished at cost plus 30 per cent.

$1,000,000 and upward, 2 per cent or same as above.

(Under (3) and (4) provision should be made in contracts requiring contractor to pay engineer or city a stipulated fee per month for delay in completing work according to contract.)

B. PER DIEM RATE

Reports, investigations, examinations, expert testimony, checking fellow engineers' work, etc.: $75 per day plus expenses up to a fee of $2,000, then $50 per day thereafter. Minimum fee, $500. Each man furnished at cost plus 35 per cent.

The American Institute of Architects sanctions a minimum fee of 6 per cent of the total cost of the work complete for architectural services. These services consist of necessary conferences, preparation of preliminary studies, working drawings, specifications, large scale and full size detail drawings, and general direction and supervision of work. Payments are due as follows: Upon completion of preliminary studies, 20 per cent of entire fee; completion of specifications and general working drawings, 40 per cent additional; remainder from time to time. At the annual meeting, May, 1920, a proposition to increase the minimum charge from 6 to 8 per cent was referred back to the chapters for study during the coming year.

Edmund T. Perkins, president Edmund T. Perkins Engineering Co., Chicago, made the following suggestions regarding charges to the Illinois Society of Engineers in 1918.

A. PERCENTAGE OF COST OF WORK:

Service	Cost of Work	Charge, Per Cent
Reconnaissance	Less than $5,000	2.0
	$5,000 to 10,000	1.75
	10,000 to 20,000	1.5
	20,000 to 50,000	1.0
	50,000 to 100,000	0.75
	100,000 to 200,000	0.5
	200,000 to 500,000	0.4
	Over..... 500,000	0.3
Preliminaries	Less than $5,000	1.5
	$5,000 to 10,000	1.0
	10,000 to 20,000	0.8
	20,000 to 50,000	0.6
	50,000 to 100,000	0.5
	100,000 to 200,000	0.4
	200,000 to 500,000	0.3
	Over..... 500,000	0.2
Plans and specifications	Less than $5,000	4.0
	$5,000 to 10,000	3.5
	10,000 to 20,000	3.0
	20,000 to 50,000	2.5
	50,000 to 100,000	2.0
	100,000 to 200,000	1.5
	200,000 to 500,000	1.3
	Over..... 500,000	1.2
Supervision (not charged for when superintendence is charged)	Less than $5,000	2.0
	$5,000 to 10,000	1.8
	10,000 to 20,000	1.5
	20,000 to 50,000	1.3
	50,000 to 100,000	1.1
	100,000 to 200,000	1.0
	200,000 to 500,000	0.8
	Over..... 500,000	0.6
Superintendence	Less than $5,000	5.0
	$5,000 to 10,000	4.5
	10,000 to 20,000	4.0
	20,000 to 50,000	3.5
	50,000 to 100,000	3.3
	100,000 to 200,000	3.0
	200,000 to 500,000	2.8
	Over..... 500,000	2.4
Alterations (relates only to value of work involved in alterations)	Less than $5,000	7.0
	$5,000 to 10,000	6.5
	10,000 to 20,000	6.0
	20,000 to 50,000	5.5
	50,000 to 100,000	5.0
	100,000 to 200,000	4.5
	200,000 to 500,000	4.0
	Over..... 500,000	3.5
Complete charge of work	Less than $5,000	12.5
	$5,000 to 10,000	10.75
	10,000 to 20,000	9.3
	20,000 to 50,000	7.9
	50,000 to 100,000	7.4
	100,000 to 200,000	6.0
	200,000 to 500,000	5.3
	Over..... 500,000	4.2

Percentages to be computed on entire cost of completed work exclusive of engineering. "Cost" refers only to such part of work as engineer may deal with.

Services generally charged for on a percentage basis include reconnaissance, preliminary reports, plans, specifications, details, supervision progress estimates, superintendence, alterations, professional advice, consultation, court work and arbitration.

B. PER DIEM RATE:

Not including expenses. Chief engineer, $500 retaining fee and $100 per day; assistant chief engineer, $50; topographical assistant engineer, and chief of party, $15 to $25; designer, $12.50; instrumentmen, draftsman and computer, $7.50; stenographer, chainman and axeman $3.50. Surveying is usually charged for on a per diem basis.

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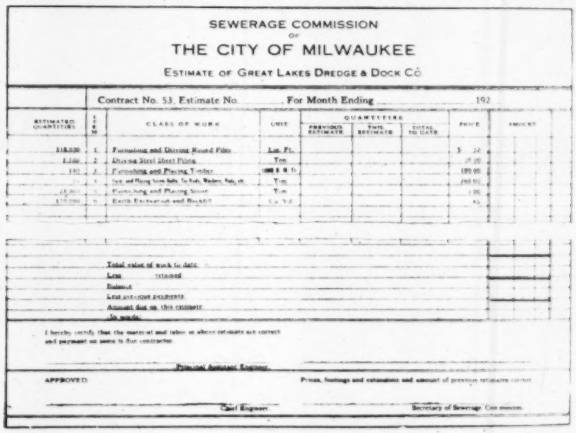
Printed Forms Standardize Monthly Cost Estimates

PRINTED forms for monthly estimates have been found highly convenient for original records of contract operations under the direction of the Sewerage Commission of Milwaukee, Wis. With many contracts in force on a great variety of work a form is printed for each contract. On each form, as the illustration indicates, is printed the estimated quantities, classes of



SEWERAGE COMMISSION
OF
THE CITY OF MILWAUKEE
ESTIMATE OF GREAT LAKES DREDGE & DOCK CO.

Contract No. 53. Estimate No. ____ For Month Ending ____ 192

ESTIMATED QUANTITIES	ITEM NO.	CLASS OF WORK	UNIT	QUANTITIES: PREVIOUS ESTIMATE	QUANTITIES: THIS ESTIMATE	QUANTITIES: TOTAL TO DATE	PRICE	AMOUNT
118,000	1	Furnishing and Driving Sheet Piles	Lin. Ft.				$ .35	
1,100	2	Driving Steel Sheet Piles	Ton				45.00	
140	3	Furnishing and Placing Timber	1000 F. B. M.				100.00	
	4	Iron and Fixings (Bolts, Tie Rods, Washers, Nuts, etc.)	Ton				200.00	
45,000	5	Furnishing and Placing Stone	Ton				1.00	
437,000	6	Earth Excavation and Backfill	Cu. Yd.				.75	

Total value of work to date
Less retained
Balance
Less previous payments
Amount due on this estimate
To words

I hereby certify that the material and labor on above estimate are correct and payment on same is due contractor.

Principal Assistant Engineer.

APPROVED

Prices, footings and extensions and amount of previous estimate verified

Chief Engineer. Secretary of Sewerage Commission.

MONTHLY ESTIMATE FORM
The original sheet was 9½ x 12 inches.

work, units of measure and contract prices. By this arrangement the engineer making the estimate or the accountant who checks the estimate is not required to call on his memory or to refer to separate records for any of the constants involved in his task. This reduces the chances of error. When the form is properly completed it gives for any month at a glance the status of the contract in respect to work done and payments authorized. The procedure is not unique in contract work but the form illustrated is convenient and its use is standard on the large construction operations referred to. T. Chalkley Hatton is chief engineer of the Milwaukee Sewerage Commission.

Study of Temperature Stresses in Rigid Pavement Slabs

By C. H. Scholer
Testing Engineer, Kansas State Highway Commission

THE Engineering Experiment Station of the Kansas State Agricultural College is conducting an extensive investigation of the stresses induced by expansion due to changes of temperature and moisture conditions in concrete and other rigid types of pavement slabs. The investigation is being made by the road materials testing laboratory of the Experiment Station which is also the official laboratory of the Kansas Highway Commission.

Although the desirability of expansion joints is seriously questioned by many highway engineers, the extreme temperature ranges and climatic variations in Kansas led M. W. Watson, state highway engineer, to request the testing laboratory to make an investigation of these phenomena in various parts of the state. The investigation has just started and it is thought that the methods and apparatus used, together with an outline of the scope of the investigation would be of interest to engineers engaged in highway construction.

The apparatus used is simple and consists of a 20-in. Berry strain gage with Ames dial which will permit

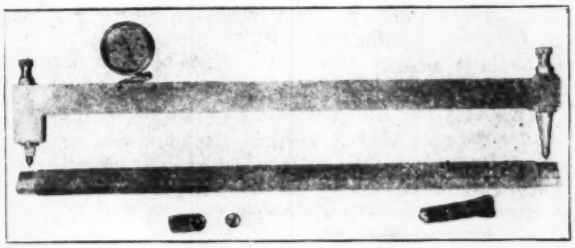


FIG. 1. STRAIN GAGE AND "ZERO BAR"

the measurement of a change between gage points of 0.0001 in. The assembled gage is shown in the illustration. The frame of the mechanism is of invar steel with a low coefficient of thermal expansion which eliminates errors due to slight temperature changes which might take place during the handling of the instrument.

The zero bar illustrated in Fig. 1. is a double bar; one bar of steel and one of aluminum which expand and contract independently of each other, but are thoroughly encased in asbestos and paper to insure their being at the same temperature and to prevent rapid changes in temperature. Gage marks on these bars consist of No. 58 drill holes slightly countersunk to prevent burring of the edges. Before wrapping in asbestos the bars were carefully calibrated together at different temperatures and a curve (see Fig. 2) plotted showing the corrections in dial divisions in the length of the steel bar in terms of the difference in length of the two bars. This makes it possible to correct for temperature changes independently of any actual temperature determinations.

Observation has shown that, knowing the difference in readings, the temperature can be computed to within 0.25 deg. C., which is considered sufficiently accurate for the work.

Gage marks are set in the plugs illustrated in Fig. 3. This plug consists of a 3-in. length of ¾-in. iron pipe crimped at one end. In the other end a short brass plug is driven leaving about ¼ in. of pipe projecting beyond the plug. The inside of the plug is then tapped to take the small brass cap which closes the pipe when in place.

A temperature plug, a pipe 4 in. long similar in every respect to the others except that it contains no

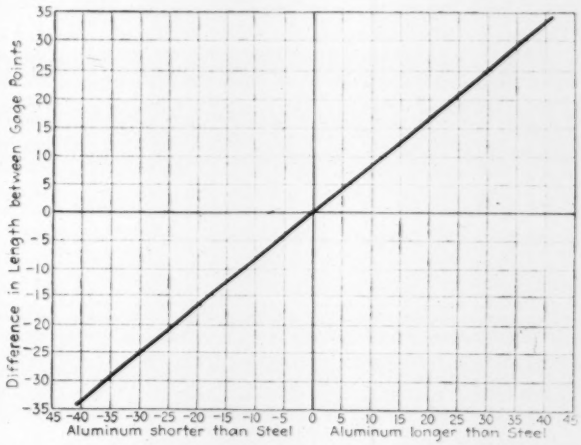


FIG. 2. CURVE SHOWS TEMPERATURE CORRECTIONS IN LENGTH OF STEEL BAR

brass plug to receive the gage mark, is also set at each station. This is later partly filled with mercury and used as a temperature well to determine the actual temperature in the slab.

Two plugs which are to receive the gage marks are set on the centerline of the pavement approximately 20 in. apart and a third plug is set at right angles to the centerline opposite and 20 in. from one of the other plugs.

The plugs are set slightly below the finished roadway surface and are kept covered with a patch of tar or asphalt filler. The patch is used not only to protect the concrete near the plugs but also to keep meddlers from finding the screw caps and tampering with them.

For two course types like monolithic brick, a set of plugs are placed in the base at the edge of the slab and independent readings secured upon these, to determine if the base tends to expand independently of the top.

Where the plugs are placed in old pavements holes are drilled to receive the plugs which are grouted in place. After the surrounding concrete has set for 24 to 48 hours, the screw caps are removed and gage marks similar to those described in the zero bar are drilled in the brass plugs 20 in. c. to c. and the initial reading secured.

In making the readings the strain gage is assembled and set at zero on the steel member of the zero bar, a reading is then made upon the aluminum member and the difference, plus or minus, recorded; a check is then made upon the steel bar to insure against possible errors in setting or disturbance of the adjustments of the instrument. The readings on the different gage lines are then made and recorded and a check again made upon the steel member of the zero bar, if any change in length is shown the operation is re-

peated. The temperature of the pavement as indicated by the mercury in the temperature plug is also recorded. From these figures the correct distance between gage marks may be computed thus: If the difference between bars gave a + 7 dial divisions by referring to the curve (see Fig. 2) the correction will be found to be + 8.5 dial divisions and the true length of the zero bar will be 20.0017 in. This length is then used as a base and the distance between gage marks is computed.

As yet no conclusions can be drawn from the data secured. The first gage station was set July 12 in

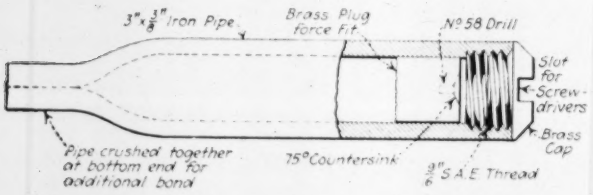


FIG. 3. EXPANSION PLUGS FOR TAKING GAGE MARKS IN PAVEMENT

Geary County, Project 10, a two-course concrete road, and it is expected that readings will be taken every 30 days. Present readings indicate a shortening between gage points. This period covers the setting of the concrete and a change of 2 deg. C. in the temperature of the concrete slab. This might easily account for the contraction noted.

Observation Checks

It is hoped that the difference in change between the transverse and longitudinal gage points may be used as a factor in computing the approximate stress in the slab due to axial forces. The gage marks at right angles to the centerline of the road will be comparatively free from restraint other than the friction on the subgrade, while along the centerline of the roadway there will be the compressive forces due to the tendency to expand and which will decrease the expansion. By noting the difference in change of length the forces can be computed.

As a further check upon this, gage points were set in a small section of slab 12 in. x 30 in., and of the same depth as the center of the pavement, placed at the side of the roadway and poured at the same time the main slab was poured. If high compressive stresses are induced in the main slab it should be possible to detect it by a comparison with this small unrestrained section.

At present stations are set in the following projects and types of construction: Project 10, Geary County, two-course concrete; Project 11, Sedgwick County, two-course concrete; Project 15, Reno County, monolithic brick; Project 26, Rice County, two-course concrete. All of these above projects are now under construction without provision for expansion. A station was also placed on a concrete road on the college campus. This road is about six years old and was provided with expansion joints.

It is expected additional stations will be set covering extreme conditions in subgrade and drainage features, and also stations set at different seasons of the year—during late fall, mid-summer and early spring construction.

Unprecedented Design Involved in Irrigation Project

To Bring Water 130 Miles to 1,753,000-Acre Columbia Basin in Washington—Viaduct, Siphons and Tunnels of Unusual Size

ENGINEERING, agricultural and financial aspects of a plan for irrigating 1,753,000 acres in Washington with water brought from the Pend Oreille River, 130 miles away, are presented in the report of the Columbia Basin Survey Commission just issued. The report contains complete preliminary plans and cost estimates for structures necessary to deliver 20,000 sec.-ft. These include a viaduct across the Spokane River with 100-ft. spans, which would carry a stream 20 ft. deep and 82 ft. wide, 80 miles of tunnels of diameters up to 33 ft., 13 dams, numerous inverted siphons up to 23 ft. in diameter and nearly a thousand miles of main and lateral canals, of which the important sections would be concrete lined. Despite the extensive work involved, to cost about $300,000,000, the area supplied is so large that the cost per acre would be only $171, which the commission finds is well within the amount that can be afforded under the very favorable soil, drainage and weather conditions.

The commission was created by legislative act of the State of Washington in March, 1919, and at the same time an appropriation of $100,000 was made for its work. State officials would like to construct the project as a state undertaking, but it is felt that the state could not finance the plan. Moreover, water rights in other states are involved. It is therefore proposed to secure Federal aid, if possible, in the form of credit guarantees. Previous reference to studies and investigations carried on by the commission appeared in *Engineering News-Record*, Nov. 6, 1919, page 800, and March 4, 1920, page 456.

The area to be irrigated lies between the Snake and Columbia Rivers just above their confluence. Surface and soil classification studies covering 3,000,000 acres showed that 1,753,000 acres which could be irrigated by the proposed gravity system are high-class irrigable land and compare favorably with land in the adjoining Yakima Valley. In this region the normal rainfall is less than 8 in., which occurs mostly in the winter time. As crop production requires 2½ or 3 ft. of water during the growing season, the region is characterized as extremely arid.

Unlike many arid regions, however, there is no accumulation of alkali salts. The underlying gravel and sand strata and the numerous deep coulees act as a natural and adequate drainage-way, the commission finds, and will prevent waterlogging. The present value of the sage-brush land is taken at $3 to $5 per acre and the cost of leveling off about $15 per acre, which, with the *pro rata* of the cost of building the irrigation works, will bring the total to $190 per acre as the cost of land and water ready to start farm operations.

The watershed to be drawn upon covers about 24,000 square miles in western Montana and northern Idaho and, with the development of some of the reservoir sites it contains, affords an ample supply for any crops suited to the area. The gross diversion is to be about 6,250,000 acre-ft., taken from the stream at a point where the annual run off varies from 11,000,000 to

20,000,000 acre-ft. An allowance of 19.25 per cent of the diverted flow is made for regulation and seepage losses in canals. The average duty of water for the tract is taken as 33 in. per annum.

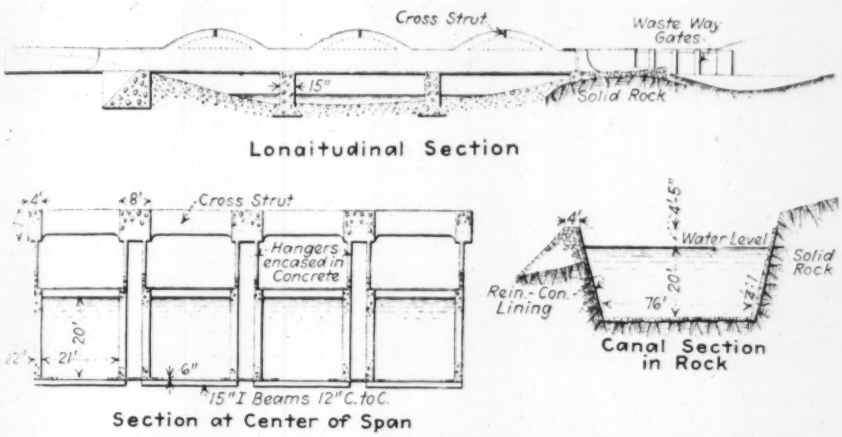
A comparison of seasons of maximum irrigation demands with seasons of maximum stream flow gave the storage required in a critical year as 2,686,000 acre-ft. By building a diversion dam at Albany Falls, Pend Oreille Lake could be used to store 1,180,000 acre-ft. at a cost of $1.01 per acre-ft. Flathead Lake in Montana could store 1,506,000 acre-ft. at a cost of $1.39 per acre-ft., and a large amount of additional storage could be created in either lake at reasonable cost if that became necessary.

Of the thirteen dams required on the main supply line ten are to be rock or rock- and earth-filled, because of the large amount of rock available from the tunnel excavations. Alternate designs and estimates were prepared in each case before deciding upon the most economical plan, and drill tests of foundations were made where the information was not otherwise available. These dams would require a total of about 30,000,000 cu.yd. of material. The largest one, on Latah Creek, would require 4,000,000 cu.yd. of rock and earth and would retain water normally to a depth of 135 ft. with a freeboard of 13 ft. The longest dam, on Deadman Creek, would have a crest length of 3,800 ft. Two of the dams include Stoney gates which, due to the necessity for placing as few piers as possible in the stream would have widths of 47 and 50 ft. respectively. The heads on these gates would be, respectively, 19.5 and 25 ft. Taintor gates are designed for the smaller canals.

In the supply canal and many of the main distributaries the large capacity required is attained partly by the use of a high velocity, 12½ ft. per second being the standard. The cross-section ranges from 1,595 to 1,658 sq.ft., the depth from 20 to 29 ft. A feature of the distributing-system design is that although the irrigation season lasts seven months, it was decided to make possible the delivery in any one month of 20 per cent of the season's requirements.

Reinforced-concrete lining is to be used in all canals of 100 sec.-ft. capacity or larger, enough reinforcing being included to provide for temperature stresses and the extra strain at all transition points. The thickness of the lining ranges from 3 to 8 in. according to the depth of water and character and slope of material. Because of the large amount of concrete lining to be placed (3,285,000 cu.yd., or an area of 23,000,000 sq.yd.) the report recommends a traveling mixer plant operating on a track in the bottom of the canal and the use of steel forms. In planning this work, as well as in that of excavating the canal itself (involving the handling of 57,000,000 cu.yd. in digging canals of capacities exceeding 100 sec.-ft.) the recommendations go into some detail in outlining methods and equipment which will require a minimum of labor.

Owing to the large sum involved in the tunnels (about $120,000,000), the route of each tunnel was examined in the field and a construction program and detailed estimates prepared by an experienced tunnel engineer as a check upon the work of the commission's engineer. On the main supply canal two parallel bores with a total capacity of 20,000 sec.-ft. were decided upon because it was not considered feasible to construct a single bore of large enough capacity to carry the entire flow. Such a bore would require a roof span exceeding 45 ft. By using two bores of more convenient dimensions, construction of the second one could be postponed until the increasing demand on the subject called for the full water supply.



CROSS-SECTION OF CANAL AND ELEVATION OF SPOKANE RIVER VIADUCT

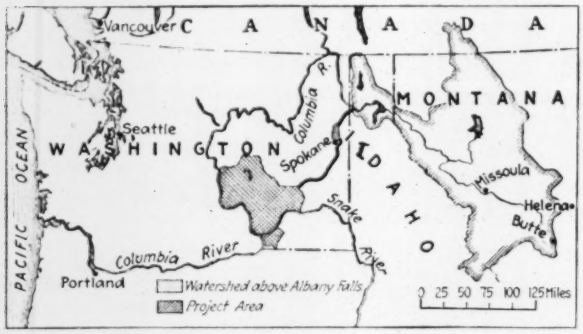
Comparing costs and the construction and operating advantages of different types, it was finally decided that on the main supply canal the first construction should be of a single-bore tunnel, 33 ft. 5 in. in diameter which would, on a grade of 3.96 ft. per mile, carry 10,000 sec.-ft. at a velocity of 12 ft. per second. In such a bore, allowing for the probable overbreak in the basaltic rock and for an average lining thickness of 17.5 in., the required excavation would be 38.53 cu.yd. and the concrete lining 5.81 cu.yd. per lineal foot of tunnel.

All of the tunnels are near railroads and it is planned to carry standard-gage tracks through them so that standard railway equipment may be used during construction. In estimating the cost, a construction program was prepared in detail providing for the driving first of those tunnels whose completion would facilitate work on the others.

The Bonnie Lake tunnel would be the determining factor in the length of time required between the starting of construction and the delivery of water. The completion of the first bore is estimated to require four summers and five winters of continuous work. The plan is to then continue with the construction of the second bore, using the same equipment, provided the rate of settlement of the project indicates that more water than the first tunnel could deliver will be required by the time the second one could be completed. The construction program for the Bonnie Lake tunnel includes three inclined shafts which, with the two portals, would afford eight working faces. A pioneer heading on the center line of the second bore would be driven to facilitate work on the first bore. All told there would be 21 tunnels over 1,000 ft. in length and ranging in diameter from 15 ft. to 33 ft. 5 in. Eight of the

largest tunnels would consist of twin bores. Although there would be some tunneling in earth, by far the greater part would be in basalt and granite.

In crossing the deep coulees with the main supply canal three methods were planned for, namely, diverting the route around the head of the coulee, crossing by means of inverted siphons, or crossing in a pond created by a dam. The avoiding of loss of head and the creation of a small regulation storage in the pond led to the adoption of the dam method wherever this was feasible. Of the thirty-three inverted siphons designed for the main canal and larger laterals, nineteen carry a flow so large that under the high heads necessary it was not considered feasible to make the crossing with one large pipe, hence two, three or four smaller pipes were recommended.



KEY MAP OF COLUMBIA BASIN PROJECT

The crossings at Wassun Creek and Cow Creek on the main canal are under heads of 141 and 121 ft. respectively and require four pipes, each 23 ft. in diameter, in which the velocity is 12 ft. per second. The Snake River crossing, 17,680 ft. in length, requires three pipes, 8 ft. 9 in. in diameter under a maximum head of 690 ft. In these pipes 24,000 tons of steel would be used. In the thirty-three siphons the length of steel pipe required would total 245,000 ft., weigh 188,500 tons and cost about $34,800,000.

The crossing of the Spokane River was found to be such that none of the three methods mentioned in the foregoing was suitable. A steel through-truss bridge was not feasible on account of the limited clearance. The design finally decided upon calls for reinforced-concrete arches from which a reinforced-concrete flume would be suspended by steel hangers extending into the arch rib. Five pairs of arches would support the flume in four sections, each 21 ft. wide by 20 ft. deep with 2 ft. of freeboard and each designed to carry its load independently. A stilling basin and spillway would be built in the upper end of this viaduct to remove the sediment and also to afford means of diverting the entire canal flow into the Spokane River in emergencies. Except for the information given on the accompanying drawing, further details about this viaduct are not given in the report.

The development of seasonal power at drops on the canal line is not included in the estimates of cost but would be feasible at about twenty-five points, varying from a 350-ft. head on a 300-sec.-ft. lateral to a 49-ft. head on a 4,950-sec.-ft. flow. In August about 175,000 hp. could be generated in this way but only a very little of this could be used to advantage in pumping water to lands above the gravity canals.

The cost estimates which are given in considerable detail include allowances for contingencies and for engineering not as arbitrary percentages but as worked out in detail for each structure. The totals include $17,500,000 for contingencies and $3,800,000 for administration, engineering and legal expense, aside from the cost of engineering design and supervision chargeable to the individual structures. The dams total $14,000,000 and the open canals, totaling 942 miles in length, $86,600,000. The tunnels figured as a single bore total 80 miles and would cost $119,400,000; inverted siphons $35,000,000; distribution system (below 100 sec.ft. capacity) $26,300,000; wasteways and drainage along the distribution system $2,400,000; lateral head-gates $400,000; and road crossings $450,000. These are the major items in the total cost of $300,475,000.

The possibility of developing a part of the area with water pumped from the Columbia River, or with a supply from Wenatchee Lake, are discussed in detail in the report, but the recommendation is for using the Pend Oreille supply as described in the foregoing.

In the act creating the commission, the state hydraulic engineer was named as chairman and directed to appoint four additional members. The personnel of the commission throughout the work has been as follows: Chairman, Marvin Chase; secretary, O. L. Waller, head of department of civil engineering, State College of Washington; E. F. Benson, state commissioner of agriculture; Peter McGregor, director, Spokane Federal Reserve Bank, and Arthur D. Jones. The engineering staff has been directed by Arthur J. Turner, as chief engineer, with J. C. Ralston, consulting engineer. The United States Reclamation Service assigned D. C. Henny and James Munn as consulting engineers to co-operate with the commission. In addition the following engineers were called in by the commission on special work: A. J. Wiley, on questions of general design, A. C. Dennis, on tunnel construction, F. E. Weymouth, on general methods of procedure, Henry Landes and Dr. Solon Shedd on the geology of dam sites.

Catskill Water Yield Figures

The sources of New York City's Catskill water system, when developed to furnish 500,000,000 gal. of water daily to all boroughs of the city, will have the following features, according to the 1919 annual report of J. Waldo Smith, chief engineer, Board of Water Supply:

Reservoir	Drainage Area, Square Miles	Reservoir Area, Square Miles	Available Storage, Million Gallons	Probable Mean Flow, Million Gallons per Day	Estimated Safe Yield, Million Gallons per Day
Ashokan	257	12.78	127,700	360	250
Schoharie	314	1.83	20,000	400	250
Catskill sources	571	14.61	147,700	760	500
Kensico	22	3.47	29,000	18	18
Catskill system	593	18.08	176,700	778	518

From the foregoing figures it will be seen that the available storage is 298,000,000 gal. per square mile of drainage area; that the probable mean flow per square mile of drainage area is 1,312,000 gal. daily, and that the estimated safe yield is at the rate of 875,000 gal. daily per square mile of drainage area.

Hints on the Writing of Engineering Reports

Discussion of Daniel W. Mead's Article in Last Week's Issue by Maj.-Gen. W. M. Black, Col. W. J. Wilgus Allen Hazen, Prof. G. F. Swain and F. Lavis

Proofs of the article entitled "Hints on the Writing of Engineering Reports," by Daniel W. Mead, published in last week's issue, p. 891, were sent to a dozen prominent consulting engineers with a request for comment on any point which Mr. Mead's discussion might suggest. The replies thus far received are reproduced below.—EDITOR.

By Maj.-Gen. W. M. Black, U. S. A., Retired

CONSULTING ENGINEER, WASHINGTON, D. C., AND FORMERLY CHIEF OF ENGINEERS, U. S. A.

THERE is little to add to the suggestions of Mr. Mead. It is rarely the case that an engineering project can not be expressed in a manner which can be easily understood by any layman. In fact, the formation of such a project usually involves simply an exercise of good judgment and common sense. The technical training of an engineer is useful mainly because his experience and habit of thought has enabled him to know what to look for and how to analyze the conditions so as to arrive at a just conclusion. The strictly technical portion of the work lies mainly in the design of the structures needed to bring about the desired results.

Almost always a report on a project comprises two distinct discussions: First, there is the statement of the ends desired, an analysis of the existing conditions and, in general terms, a description of the work to be done to change those conditions so as to produce the desired results, accompanied by a general estimate of cost. All of this can and should be so clearly expressed as to be understood by anyone. The second part is the technical discussion of the design of the works required. It is this which must be accepted largely on faith by a non-professional reader.

Clarity of expression results from clarity of thinking. If the writer of a report has in his mind a clear conception of the problem, of the attending conditions, and of the steps to be taken to make the required modification of the conditions, he should be able to describe this mental picture clearly and intelligently. If the mental picture be blurred his description will be confused.

In writing a report it is essential that each sentence shall convey but one meaning. To this end sentences should be short. Semicolons and colons should have but a limited use. Too frequently they cause sentences to be involved and the exact meaning obscure. Adjectives should be omitted unless necessary to the sense. Otherwise they weaken a statement.

By Allen Hazen

CONSULTING ENGINEER, NEW YORK CITY

I have read Mr. Mead's article on engineering reports with interest and I heartily commend what he has said. In my experience I should say that a majority of technical matters necessarily brought into reports can be reduced to simple terms and expressed in language that will be understood by intelligent people who do not have engineering training. It is always good policy to make a serious effort to bring all important matters to this degree of simplicity.

Matters that are so intricate that they cannot be treated in this way are usually best handled by being worked up clearly with a memorandum explaining how the calculations were made and the reasons for the various steps, and either placed in an appendix or more often filed as supporting data, for delivery to the client only in case of need. In a great majority of cases there is no need of ever delivering them; but such filed statements are constantly used as data in studying subsequent problems, to which they are applicable.

By F. Lavis

CONSULTING ENGINEER, AMERICAN INTERNATIONAL CORPORATION, NEW YORK CITY

There seems little to add to what Mr. Mead has said. It may, however, be necessary to emphasize the need of reading his article very carefully because so much of value is said in such a short space.

The essence of a good report is an orderly presentation of the facts, beginning at the beginning and going through, in order, to the end. This may seem a trite saying but nevertheless the lack of appreciation of this fact or inability to accomplish it is the fault of most reports—that is, assuming of course that those who make them have the necessary technical experience and ability themselves to appreciate the situation.

A much discussed point is the question of length. Personally I believe a report should be quite full and complete as to the description of the situation, its analysis, and the writer's conclusions, so that others than the author may analyze the situation if they wish. Appendices covering various matters of relative, but not direct, interest can often be used to advantage; the whole should be made easily available by a good index. A brief summary of the facts and conclusions, which are all that some persons will need or have time to read, should precede the report.

It is surprising how often such details as the name of the writer, the date, and a proper title page, are omitted, also a brief note as to how and when the examination was made, the methods used, etc.

Mr. Mead refers particularly to the need of presenting reports, when necessary, in such a way that non-technical readers or hearers can understand them. This, of course, has been said before, but it can hardly be emphasized too much. The principal trouble with those who fail to accomplish this is that they fail first in ability to put themselves in the state of mind of persons who know nothing of the subject, and then in lack of ability to start at the beginning and go through the story in order to the end. This I mentioned before, but in the very many reports I have occasion to read this seems the greatest fault.

One other point which might well be emphasized for the younger engineers, to whom, as I understand it, Mr. Mead's remarks are addressed, is that ability to write or speak to an audience requires practice. If anyone will sit down and attempt to write a description of a piece of work he thinks he is reasonably well or quite familiar with he will be surprised to find how much he doesn't know about it. Practice in writing in this way will soon indicate methods of recording pertinent facts

and develop ability in their orderly presentation. An interesting test for beginners, and even for others, is to set aside what has been written, for a month or more, perhaps for a year or so, and then go back and read it over, noting particularly any phrase or sentence that is not immediately clear at the first glance. After the lapse of a year or so, one will often be more nearly in the position of the uninformed layman and can appreciate better the lack of description which is necessary for the information of those unfamiliar with the subject.

By George F. Swain

PROFESSOR OF CIVIL ENGINEERING, HARVARD UNIVERSITY

I have read Mr. Mead's paper with great interest and entirely agree with everything that he says. It is excellently put.

The main point, in my mind, is for the engineer to state his results in a logical way and in language which is untechnical, so far as possible, and suited for the comprehension of those to whom it is addressed or who may be expected to read it. Technical matters should be placed in appendices.

I think engineers make the great mistake, in general, of using language which is too technical and not suited for the comprehension of those who are to read it.

By Col. William J. Wilgus

CONSULTING ENGINEER, NEW YORK CITY

There is very little that I can add to Mr. Mead's admirable outline of the fundamentals of an engineering report. A thorough digesting of the results of an exhaustive investigation of the matter under consideration is, of course, the first desideratum, coupled often with the drafting of summaries from which information may be taken at will. With a mastery of the subject gained in this manner it is possible briefly to express the findings and recommendations in the foreword or introduction of the report, followed by the details, suitably captioned and arranged in logical sequence, and closing with concise and definite conclusions, all couched in language and terms readily understandable by the lay reader, and supplemented by appendices containing supporting data of a purely technical nature.

The perfecting of the mechanical features of the report is also well worth while. A suitable cover, title-page and table of contents, strict accuracy, neatness of typography and convenient arrangement of maps and illustrations, and uniformity of size of sheets and folded attachments will go far toward creating the desired impression.

With a report framed in this manner those who have not the time or inclination to arrive at an independent judgment, and who prefer to rely solely on that of the engineer, will get all that they require in the first few pages; the less easily convinced reader will go through the report to the end; while the technician, in his desire to verify the conclusions expressed in the report, will even examine each appendix with care. Thus each reader is given as little or as much as he desires in order that he may be satisfied as to the merits of the subject in question.

It is a good rule for the engineer in drafting his report to imagine himself in the place of the prospective reader, and then endeavor to supply the character of simply expressed information that he would himself desire were he a non-engineer and entirely unacquainted with the subject. This attitude will usually aid very materially in bridging the gap, too often left ajar, between the highly technical work of the engineer and the lay mind which, directly or indirectly, will play some part in its consideration.

Sink Holes in Canals Stopped By Swelling of Ground

Former Lake Bed, in Drying, Left Subterranean Cracks—Dynamite or Dirt in Sacks of No Avail—Caving Into Large Holes Held

WITH the first operation of laterals constructed in the silt or "rock meal" soils on the Flathead project of the U. S. Reclamation Service, troubles began from sink holes or break through the bottom of the ditches. C. J. Moody, engineerfor the project, describes in the August *Reclamation Record* the methods of repair used, but he concludes that the only permanent cure is the swelling of the lower earth strata absorbing moisture from the water in the canal. His notes follow:

Some of these holes extended vertically into the ground and apparently had no outlet. Others dropped for a few feet and then found an outlet underground across adjacent fields, causing a caving in of the ditch banks and the topsoil of the fields for varying distances up to several hundred feet. The width and depth of these cave-ins varied from 2 or 3 ft. to a maximum of 15 ft. deep and 30 ft. wide. Where the holes dropped vertically without breaking out in the fields it was found best to allow water to run into the hole for a considerable period, as the hole would generally plug itself and fill up with water, after which necessary repair work consisted in bringing the banks and bottom up to grade with team forces. When the breaks started out across the fields it was necessary to shut out the water from the break to prevent more damage to the lands. In some cases the relocation of the lateral was the most economical solution of the repair work, but generally the break in the bank was trimmed down so that the new dirt was placed against sloping sides and topsoil used in the new bank. Water was kept in the ditch as much as possible during the time of repairing in order that the new material might be well puddled in.

REPAIR METHODS

The repair of these breaks in level country is not a serious matter but for the fact that they are very numerous. It has not been uncommon to have 20 or more in a mile of ditch, breaking in succession as soon as preceding ones are repaired and water again turned in. A more serious type of these appeared in the Camas A canal between miles 8 and 10 where the location is on steep sidehill with light topsoil with the excavation cutting into the stratified subsoil. The first water taken into this canal dropped into cracks in the bottom in a multitude of places, went down vertically from 5 to 15 ft. and came out through the hill below the bank sometimes 40 ft. lower than the canal grade. As the stratified material does not cut badly it was possible to turn out the water in the canal before these holes had assumed much area. A part of the season of 1918 was spent trying to repair these holes by refilling with good material immediately after the break occurred. Shooting the hole with low percentage dynamite and then puddling with good material was also tried. Dirt in sacks in the bottom of the hole with good puddled material on top was another method. None of these expedients proved capable of holding even under a very small head of water. It was found necessary to allow a considerable head of water to run through the break until a hole 6 or 8 ft. in diameter had been cut through the subsoil and all of the cracks leading into the one which had caused the break were cut out. These holes were generaly at such depth under the canal

bank that the bank did not fail. The first step in the repair work was to trim the sides of the opening to as flat a slope as possible without moving much material. This slope was generally about 1:1. The canal bank, which was largely sandy loam and clay material was caved down into the opening. Sandy loam was available fortunately on the upper side of the canal and was used in filling the break. Water was kept against the new bank during the process of filling and was turned through the canal as soon as the repair work was completed. Up to January, 1920, none of the places repaired in this manner had broken the second time. During the fall of 1918 a large number of breaks were repaired in this manner. In 1919 on this canal there were 12 breaks in April, 6 during May and 1 in July. One new hole showed up in the spring of 1920.

The largest number of sink holes appeared during the first and second year of operation, but are still occurring with less frequency after four years of operation. They also occur in fields where irrigation water is applied.

An explanation of the cause of these holes is that the subsoil which lies in horizontal strata has contracted during the drying-out process following the time when the country was a lake bed, and vertical cracks have been formed. When the light soil covering the stratified material becomes saturated sufficiently, water breaks through into the cracks and carries considerable quantities of the soluble topsoil into the crevices. Some of these must be to a great depth vertically, and others are cut off by a horizontal stratum and are open for a considerable distance parallel to the surface of the ground.

Salinity Effect on Action of Teredoes

A study of the action of marine borers in San Francisco Bay, reported in a zoology paper by Albert L. Barrows, published by the University of California, finds that once established the teredo can withstand for several weeks or perhaps months a reduction of salinity to about ten parts per thousand, though it must have an average of at least thirteen or fourteen parts per thousand in order to thrive. In upper San Francisco Bay waters where the teredo is much more active at the mud line than near the surface, the mud line salinity was found to be consistently greater than at the surface; sometimes as much as 4.28 parts per thousand greater. Another peculiarity is that the teredo was found to be very sensitive to the amount of water in circulation around the place where it settles. By way of explanation the report states: "It is possible that the relation of the teredo to salinity may be only an indirect one and at least partly dependent upon some other cause, such as the presence of certain organisms upon which the teredo may feed to the best advantage, which are in their turn directly dependent upon water of a certain density for flotation or of a certain salinity for their own physiologic well being."

New System of Track Work Records On St. L.-S. F. Ry.

Foremen Report Time and Amount of Work in Detail Classification—Figures Extended to Cover Operating Divisions

AS COST RECORDS of railway maintenance of way work are becoming of greater importance under present conditions of labor and material, and as such records must be based upon the daily reports of foremen of section gangs and extra gangs, the St. Louis-San Francisco Ry. has established a new system of reports which is designed to give more complete and reliable figures than have been available under former systems. It has been pointed out by F. G. Jonah, chief engineer, that formerly the foreman reported only the amount of time spent on different kinds of work, nothing being said as to the quantity of work done in the stated time (see *Engineering News-Record*, Sept. 30, p. 662.)

TIME BOOK for the FIRST HALF — of Month of 19

NAMES		1	2	3	4	5	6	7	Total Hours	Rate	Amount Earned	DEDUCTIONS: Board	Misc.	Net Amount Due	Identification Check Number
	Straight Time														
	Over Time														
	Straight Time														
	Over Time														
	Straight Time														
	Over Time														

FIG. 1. SECTION FOREMAN'S DAILY TIME REPORT

A form of report which provides for records of time spent and work done is the basis of the new system. In the first place, the foreman is provided each month with a "foreman's pocket time distribution and material book," which he keeps with him on the work and in which he enters the names of the men employed. During the day he notes in his own language what the men are doing and how much they have done. At the close of the day's work, these figures are transferred to the semi-monthly time book. The foreman's pocket time book is 4 x 6¾ in. with stiff fiber-board covers. The first few double pages are ruled as shown in Fig. 1, and it will be noted that separate space is provided for reporting "overtime." Following this are double pages for daily distribution of work, ruled as shown in Fig. 2. In these are recorded the kinds of work, the location, time spent in each

DAILY DISTRIBUTION — Month ____ Date ____ 19____

Description of work done use SEPARATE Line for each class Work	Kind or Name of Track or Structure (See Instructions)	Location Mile Post or Station	Track Letter	Number Units	Total Hours

MATERIAL USED

No. of Pieces	New or Old	DESCRIPTION (Show Kind and Size)	Track Letter

MATERIAL RELEASED

No. of Pieces	DESCRIPTION (Show Kind and Size)	Second Hand	Scrap	Track Letter

FIG. 2. FOREMAN'S DAILY WORK REPORT

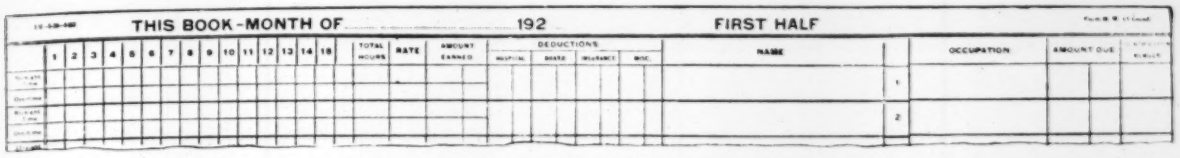
ST. LOUIS-SAN FRANCISCO RAILWAY LINES

Section and Extra Gang Labor—Number of Units and Average Cost per Unit by Kinds of Work
Month of July, 1920
Recapitulation by Divisions, Districts and Total Entire Line

Item No.	Kind of Work	Units and Unit Cost	Eastern	South-Western	Western	Northern	Southern	River & Cape	Total Northern District	Central	Red River	Total Southern District	Texas Lines	Total System	Item No.
1	Cleaning weeds from track	Trk.ft.	676,386	917,873	1,631,821	1,283,730	635,100	1,499,732	6,644,642	1,113,715	375,957	1,489,672	605,333	8,739,647	1
		Cost	$0 01	$0 01	$0 01	$0 01	$0 02	$0 01	$0 01	$0 02	$0 02	$0 02	$0 02	$0 01	
2	Cleaning ditches in cuts	Lin.ft.	150,365	12,190	34,745	92,005	114,591	7,233	411,129	110,530	4,804	115,334	86,402	612,865	2
		Cost	$0 17	$0 06	$0 02	$0 03	$0 09	$0 08	$0 10	$0 06	$0 06	$0 06	$0 05	$0 09	
3	Cleaning surface ditches	Lin.ft.	59,422	19,260	5,600	57,521	35,275	1,352	178,430	10,772	2,100	12,872	12,955	204,257	3
		Cost	$0 05	$0 03	$0 02	$0 02	$0 03	$0 03	$0 03	$0 04	$0 04	$0 04	$0 08	$0 03	
4	Mowing and burning right of way	Trk.ft.	572,285	356,725	536,805	1,415,316	876,924	779,118	4,537,173	162,672	156,310	318,982	149,916	5,006,071	4
		Cost	$0 005	$0 008	$0 006	$0 006	$0 01	$0 003	$0 007	$0 008	$0 008	$0 008	$0 004	$0 007	
5	Unloading ballast	Cars	164	84	634	124	250	361	1,617	29	304	333	36	1,986	5
		Cost	$3 67	$4 01	$6 42	$3 42	$3 58	$2 26	$4 42	$4 89	$2 12	$2 36	$6.95	$4 12	
6	Applying chats and gravel ballast	Trk.ft.	1,775	26,755	19,192	8,660	.....	120	56,502	.....	1,941	1,941	.....	58,443	6
		Cost	$0 06	$0 04	$0 12	$0 04	.....	$0 06	$0 07	.....	$0 06	$0 06	.....	$0 07	
7	Applying slag and rock ballast	Trk.ft.	150	.....	3,227	650	9,055	8,296	21,378	.....	1,058	1,058	2,020	24,456	7
		Cost	$0 42	.....	$0 21	$0 13	$0 08	$0 06	$0 09	.....	$0 13	$0 13	$0 15	$0 10	
8	Applying cinder, sand or other ballast	Trk.ft.	6,755	550	4,402	7,040	12,900	8,170	39,817	5,614	300	5,914	.....	45,731	8
		Cost	$0 08	$0 13	$0 06	$0 06	$0 13	$0 10	$0 09	$0 14	$0 09	$0 14	.....	$0 10	
9	Inserting ties in chats and gravel ballast	Ties	14,225	4,761	2,876	12,282	7,148	4,851	46,143	6,442	378	6,820	4,252	57,215	9
		Cost	$0 44	$0 52	$0 55	$0 44	$0 45	$0 38	$0 45	$0 40	$0 53	$0 41	$0 39	$0 44	
10	Inserting ties in slag and rock ballast	Ties	5,729	163	17	447	14,263	3,204	23,823	745	4,788	5,533	54	29,410	10
		Cost	$0 43	$0 59	$1 13	$0 57	$0 37	$0 44	$0 40	$0 64	$0 46	$0 48	$0 64	$0 42	
11	Inserting ties in sand, cinders or earth	Ties	20,430	1,159	11,081	11,534	11,843	24,691	80,738	9,804	3,722	13,526	8,753	103,017	11
		Cost	$0 30	$0 55	$0 32	$0 35	$0 37	$0 37	$0 34	$0 31	$0 55	$0 38	$0 39	$0 35	
12	Surfacing track on chats or gravel	Trk.ft.	224,152	182,458	79,335	387,831	62,289	85,187	1,021,252	99,359	5,545	104,904	53,729	1,179,885	12
		Cost	$0 07	$0 06	$0 09	$0 05	$0 09	$0 05	$0 06	$0 09	$0 11	$0 09	$0 10	$0 07	
13	Surfacing track on slag or rock	Trk.ft.	40,950	17,300	594	2,170	137,990	29,110	228,114	14,104	76,815	90,919	2,590	321,623	13
		Cost	$0 07	$0 01	$0 05	$0 04	$0 12	$0 07	$0 10	$0 11	$0 14	$0 14	$0 10	$0 11	
14	Surfacing track on sand, cinders or earth	Trk.ft.	77,672	23,431	158,751	62,196	104,707	125,065	551,822	74,641	38,447	113,088	47,230	712,140	14
		Cost	$0 10	$0 09	$0 08	$0 08	$0 12	$0 08	$0 09	$0 10	$0 11	$0 10	$0 12	$0 09	
15	Unloading rail	Lin.ft.	11,049	5,486	18,579	76,245	69,429	147,105	327,893	.....	.....	.....	.....	327,893	15
		Cost	$0 01	$0 008	$0 003	$0 007	$0 009	$0 005	$0 007	.....	.....	.....	.....	$0 007	
16	Loading rail	Lin.ft.	5,916	8,342	8,922	13,450	5,723	36,982	79,335	.....	.....	.....	.....	79,335	16
		Cost	$0 01	$0 004	$0 006	$0 01	$0 02	$0 007	$0 009	.....	.....	.....	.....	$0 009	
17	Laying rail	Trk.ft.	3 428	2,648	528	9,874	47,390	16,179	82,047	426	110	536	75	82,658	17
		Cost	$0 10	$0 18	$0 09	$0 08	$0 06	$0 15	$0 09	$0.15	$0 35	$0 19	$0 24	$0 09	
18	Lining and gauging track	Trk.ft.	22,664	44,665	38,467	65,581	90,163	32,847	294,387	39,305	15,745	55,050	26,795	376,232	18
		Cost	$0 06	$0 04	$0 02	$0 04	$0 02	$0 03	$0 03	$0 01	$0 03	$0 02	$0 03	$0 03	
19	Applying rail anchors	Number	19	90	.....	490	2,950	.....	3,549	400	.....	400	.....	3,949	19
		Cost	$0 12	$0 49	.....	$0 05	$0 005	.....	$0 02	$0 07	.....	$0 07	.....	$0 03	
20	Applying tie plates	Number	15,000	15	.....	.....	5,607	3,746	24,368	.....	.....	.....	400	24,768	20
		Cost	$0.001	$0 32	.....	.....	$0 002	$0 02	$0 005	.....	.....	.....	$0 12	$0 006	
21	Repairing signs	Number	200	.....	19	10	.....	.....	229	.....	.....	.....	.....	229	21
		Cost	$0 06	.....	$2 79	$0 82	.....	.....	$0 32	.....	.....	.....	.....	$0 32	
22	Repairing right of way fences	Rod	3,891	386	36,734	4,867	2,482	14,069	62,429	9,602	1,692	11,294	315	74,038	22
		Cost	$0 66	$0 45	$0 007	$0 14	$0 25	$0 03	$0 08	$0 04	$0 02	$0 04	$0 13	$0 07	
23	Repairing cattle guards and wing fences	Number	40	2	225	187	45	31	530	17	.....	17	.....	547	23
		Cost	$2 14	$1 44	$2 88	$0 70	$3 72	$4 89	$2 24	$3 75	.....	$3 75	.....	$2 29	
24	Repairing grade crossings	Number	30	.....	122	80	12	18	262	13	8	21	6	289	24
		Cost	$3 07	.....	$1 68	$3 81	$14 13	$5 02	$3 29	$13 88	$9 24	$12 11	$25 10	$4 38	
25	Unloading coal for station use	Tons	.....	10	40	2	287	.....	339	171	85	256	.....	595	25
		Cost	.....	$0 42	$0 85	$0 48	$0 45	.....	$0 50	$0 87	$0 26	$0.67	.....	$0 57	
26	Unloading coal for water stations	Tons	32	25	83	130	86	36	392	.....	.....	.....	.....	392	26
		Cost	$0 13	$0 09	$0 62	$0 27	$0 33	$0 32	$0 34	.....	.....	.....	.....	$0 34	
27	Patroling track	Hours	7,168	3,331	1,909	7,891	5,504	5,555	31,358	2,157	355	2,512	1,930	35,800	27
28	Repairing roadbed damaged by washouts	Hours	131	21	333	503	983	92	2,063	498	8	506	30	2,599	28
29	Loading and unloading ties	Hours	3,226	638	1,915	1,979	6,382	2,929	17,069	994	593	1,587	1,623	20,279	29
30	Applying frogs and switches	Hours	2,356	823	271	3,237	2,846	1,290	10,823	1,033	1,276	2,309	371	13,503	30
31	Applying other track material	Hours	4,379	7,303	10,488	10,183	9,490	5,137	46,980	5,760	4,705	10,465	1,344	58,789	31
32	Repairing track damaged by washouts	Hours	274	427	367	778	390	515	2,751	310	.....	310	161	3,222	32
33	Repairing track damaged by wrecks	Hours	1,506	525	923	2,024	2,863	421	8,262	1,460	888	2,348	3,653	14,263	33
34	Cleaning and scrubbing station buildings	Hours	125	2,919	40	473	1,344	485	5,386	64	73	137	.....	5,523	34
35	Transferring and handling freight at stations	Hours	533	1,261	634	231	4,220	309	7,188	134	165	299	225	7,612	35
36	Care of switch lamps outside switch yards	Hours	641	1,084	188	1,973	1,303	2,097	7,286	1,702	786	2,488	102	9,876	36
37	Care of switch lamps in switch yards	Hours	1,465	2,367	1,253	2,201	2,862	1,000	11,148	1,363	1,401	2,764	663	14,575	37
38	Care of signal lamps	Hours	2,385	72	136	2,029	2,171	798	7,591	27	.....	27	1,450	9,068	38
39	Watching crossings	Hours	12,679	10,560	2,447	6,931	1,948	1,456	36,021	1,084	1,536	2,620	2,848	41,489	39
40	Clearing wrecks, transferring freight and baggage	Hours	4,278	420	854	738	1,693	.....	7,983	1,027	36	1,063	40	9,086	40
41	Removing and burying stock killed	Hours	163	109	54	368	739	209	1,642	547	216	163	54	2,459	41
42	Removing snow, ice and sand from platform and tracks	Hours	784	19	110	1,533	67	23	2,536	.....	229	229	.....	2,765	42
43	Signals and interlockers	Hours	1,189	.....	30	999	2,210	95	4,523	7	31	38	528	5,089	43
44	Care of station grounds	Hours	7,457	4,907	4,467	6,446	8,598	2,864	34,739	2,438	2,988	5,426	1,324	41,489	44
45	New work	Hours	22,935	5,468	8,944	7,928	10,135	878	56,288	641	2,224	2,865	999	60,152	45
46	All other work not classified above	Hours	86,995	49,613	32,120	46,653	58,647	36,527	310,555	45,398	27,730	73,128	89,955	473 638	46

case, and the material used or released. Other pages are for detailed reports of rails, ties and other materials received and shipped, also material released from tracks taken up and abandoned. A page for daily report of motor car service is shown in Fig. 3. The total hours of work shown in the daily record are to be balanced with the total shown on the time sheet in the front part of the book. Instructions as to the use of the book are printed on the opening pages.

Classification of tracks on which work is done is a special feature of the system. Thus the daily distribution report, Fig. 2, has a column headed "track


THIS BOOK-MONTH OF ..... 192 ..... FIRST HALF

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTAL HOURS	RATE	AMOUNT EARNED	DEDUCTIONS				NAME		OCCUPATION	AMOUNT DUE		
																			HOSPITAL	BOARD	INSURANCE	MISC.						
																								1				
																								2				

FIG. 4. SEMI-MONTHLY TIME REPORT

letter," in which is entered the letter for one of the 26 classifications, which are as follows:

A. First and second main tracks.
B. Passing tracks.
C. Team tracks.
D. Industry tracks.
E. Stockyard tracks.
F. Tracks at division or train terminals used exclusively, or nearly so, for reclassifying and storing through trains and passing them through yards. By "through" trains are meant those which are not started or terminated at the station where they use these reclassifying or storage tracks.
G. Tracks used exclusively, or substantially so, for making up or breaking up freight trains starting or terminating at that particular station.
H. Tracks used exclusively, or nearly so, for making up and breaking up passenger trains.
I. Tracks used for storing caboose cars.
J. Tracks used for storing passenger equipment.
K. Tracks used for storing wrecking and work outfits.
L. Storage tracks for bad order freight cars.
M. Storage tracks for bad order passenger cars.
N. Passenger depot tracks.
O. Freight house tracks.
P. Car to car transfer tracks.
Q. Scale tracks.
R. Freight car repair tracks.
S. Passenger car repair tracks.
T. Shop and all Mechanical Department tracks not otherwise specified.
U. Coach cleaning tracks.
V. Tracks to and from coal chutes.
W. Enginehouse tracks.
X. Turntable tracks.
Y. Wye tracks.
Z. Company material tracks.

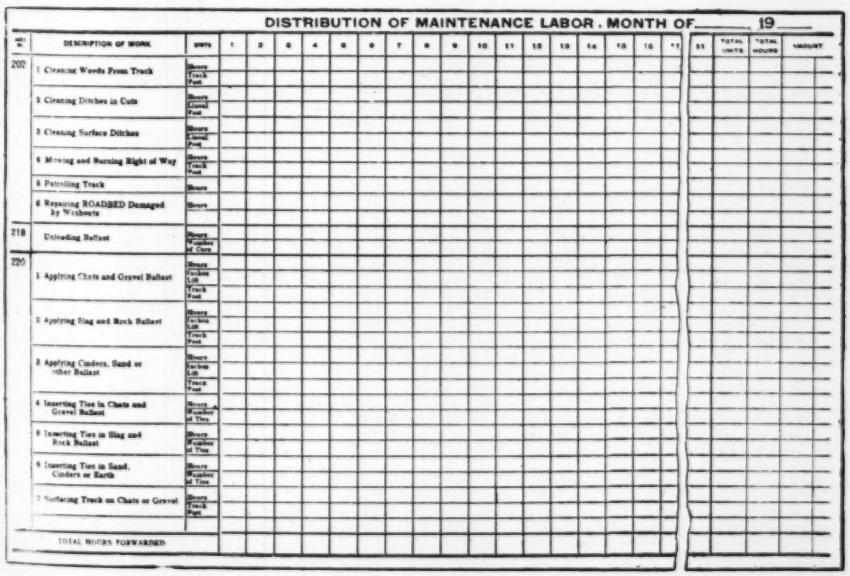
For the semi-monthly report covering the first half of the month a sheet 17 x 9½ in. is used, ruled as shown in Fig. 4. This is to be made up daily and sent to the roadmaster on the fifteenth of the month. A more elaborate report is made for the second half of the month, with additional information for the entire month. This has pages 10 x 9½ in., the first few pages being very similar to Fig. 4. Beyond these are pages giving the time and amount of work of various kinds for each day of the month, a portion of this part of the report being shown in Fig. 5. There are 46 different items, and for accounting purposes these are arranged under the designations of various accounts, as shown. They include also separate divisions for maintenance labor, transportation labor and labor on new work. The second of these divisions is to show what proportion of the section gang's time is taken up by labor chargeable to transportation accounts, such as cleaning stations, unloading coal for stations, caring for switch and signal lamps. The third division includes grading, unloading ballast, tracklaying and removing tracks. It was desired to get cost data on the essential work of track maintenance, and for this reason the headings for distribution of time are given so plainly that the foreman should have no difficulty in transferring the figures correctly from his pocket time book to the distribution sheet. For accounting purposes, it was necessary to group work under various account numbers. These accounts and the subdivisions of work are as shown in the accompanying table.

DAILY MOTOR CAR REPORT 5

Date	Miles Run	Number of Men	Number of Pounds Carried	USED			
				Gallons Gasoline	Gallons Kerosene	Quarts Oil	Pounds Grease
1							
2							
3							
29							
30							
31							
Total							

No. ..... Batteries used during month No. ..... Bolts used during month
No. ..... Spark-plugs used during month .....

FIG. 3. REPORT OF SECTION MOTOR CAR SERVICE


DISTRIBUTION OF MAINTENANCE LABOR. MONTH OF ..... 19 .....

NO.	DESCRIPTION OF WORK	UNITS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	31	TOTAL UNITS	TOTAL HOURS	AMOUNT
202	1 Cleaning Weeds From Track	Hours Track Feet																					
	2 Cleaning Ditches in Cuts	Hours Linear Feet																					
	3 Cleaning Surface Ditches	Hours Linear Feet																					
	4 Mowing and Burning Right of Way	Hours Track Feet																					
	5 Patrolling Track	Hours																					
	6 Repairing ROADBED Damaged by Washouts	Hours																					
218	Unloading Ballast	Hours Number of Cars																					
220	1 Applying Chats and Gravel Ballast	Hours Cubic Yards Lift Track Feet																					
	2 Applying Slag and Rock Ballast	Hours Cubic Yards Lift Track Feet																					
	3 Applying Cinders, Sand or other Ballast	Hours Cubic Yards Lift Track Feet																					
	4 Inserting Ties in Chats and Gravel Ballast	Hours Number of Ties																					
	5 Inserting Ties in Slag and Rock Ballast	Hours Number of Ties																					
	6 Inserting Ties in Sand, Cinders or Earth	Hours Number of Ties																					
	7 Surfacing Track on Chats or Gravel	Hours Track Feet																					
	TOTAL HOURS FORWARDED																						

FIG. 5. PORTION OF MONTHLY WORK REPORT

The semi-monthly time books go from the roadmasters to the Bureau of Accounts, where the payrolls and distribution are made up and where the statistics relating to unit costs are compiled. The figures are made up in

sheets, covering definite territory. There is first a grouping of all the sections on a roadmaster's territory with the costs of the various kinds of work on each section, and an average for the whole territory. Second, a grouping of the average of the roadmasters on a division. Third, the average of all the divisions in a district, together with the average for the entire system. The figures are reviewed by the district engineers and attention is directed to work on any territory or section which seems out of line. In the accompanying table is shown a portion of the sheet for the eleven divisions and districts, with the summary for the entire system, the figures being for the month of July, 1920. The left hand column of description of work is the same on all the three sheets. On the roadmaster's sheet the column headings are the names of the roadmasters, and on the section sheets the headings are the designations of the track sections.

This system of track reports and accounting was devised by F. G. Jonah, chief engineer of the St. Louis-San Francisco Ry., in conjunction with the railway company's accounting bureau. It has been in operation since February, 1920. When the new time books were first issued, instructors went over the road explaining to the section foreman what was wanted and how they were to make out the reports. There has been little trouble from inaccurate or incomplete figures and the reports are found to improve steadily.

Treated Wood Spoiled by Cutting

CARELESSNESS in the use of treated timber in railway work by cutting and boring the pieces so as to expose untreated or lightly treated surfaces is a common condition which causes waste of money and material and a shortened life of the timber and is likely to be taken as an argument against the value of preservative treatment. This situation is pointed out emphatically in a report on the abuse of treated timber, presented at the recent annual meeting of the American Railway Bridge and Building Association.

Specific instances of such abuse are the cropping of piles after driving without applying preservative to the exposed surface, boring and framing treated sticks and adzing piles to form a bearing for braces. The heads of cropped piles should be coated with hot creosote oil until the wood will take up no more oil. Holes should be bored for a driving fit, or hot creosote oil should be poured into them. If piles are not in line after driving, it is better to apply blocks to bring the bracing into line rather than to cut away the surface of the pile for this purpose. In general, all portions of treated timber which have been cut or bored below the penetration of the creosote should be covered thoroughly with hot creosote oil. Further, treated timbers should not be so handled with bars, picks or hooks as to make holes extending through the treated surface.

Several examples of bad practice are given in the committee report, which points out that they are not the results of malicious intent but of lack of thoughtfulness and instruction. Similar practices are being repeated daily in all parts of the country and are the cause of many reported failures of treated material. The committee states that timber will not decay if it is properly seasoned, is well treated with creosote and is so handled and used that the seal of the treated area of the wood is not broken.

Notes from Foreign Fields

THE RAILWAYS OF THE ORIENT

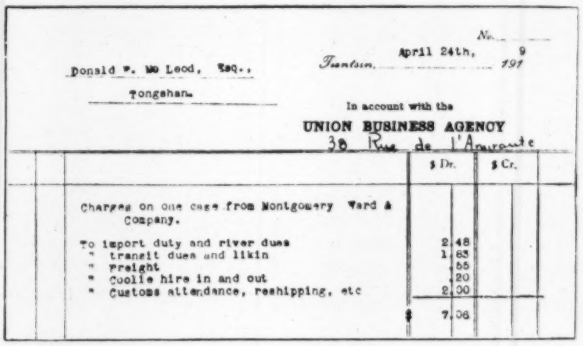
BY DONALD F. MCLEOD
Formerly of Chinese Government Engineering College

CHINA has nearly half of the railway mileage of the Orient. The total is about 20,000 miles, distributed as follows:

	English Miles
In China	10,000
In Japanese Empire, including Taiwan (Formosa) and Sakhalin, but not Chosen (Korea)	6,500
In Chosen	850
In Burmah, Siam, Malaysia, Indo-China and the Philippine Islands	3,000
Total	20,350

The types of rolling stock and construction of roadbed are for the most part European. The dining cars and freight cars of the South Manchurian and Chosen Railways are of American type. The locomotives on these roads are mostly American, and there are many American locomotives on the Peking-Mukden Ry., the Peking-Suiyuan (Kalgan) Ry., and some others.

Twice within the past three years the writer has traveled the 2,150 miles of railway route, including



No.
Tientsin, April 24th, 9 797

Donald F. McLeod, Esq.,
Tongshan.

In account with the
UNION BUSINESS AGENCY
38 Rue de l'Amiraute

	$ Dr.	$ Cr.
Charges on One case from Montgomery Ward & Company.		
To import duty and river dues	2 48	
" transit dues and likin	1 63	
" freight	55	
" Coolie hire in and out	20	
" Customs attendance, reshipping, etc	2 00	
	$ 7.06	

TRANSPORTATION CHARGES—CHICAGO TO TONGSHAN

ferry-boat trip of 170 miles, between Yokohama and Peking. There is little to choose between in traveling on this line and a similar length of railway journey in America. One does not recognize the names of the stations when they are announced by the trainman; but this is the case, not infrequently, in America. The seating arrangement is not so comfortable in the narrow-gage coaches of the Japanese railways as in American passenger cars. The former consists of two long seats facing one another along the sides of the car. The speed is moderate, being about 26 miles per hour, including stops. The stops, however, take up considerable time. At many of the twenty-five, and more, halting places between Tokyo and Shimonoseki, 700 miles, the length of stop is from eight to ten minutes. One of the features of the stop is the trundling out on the platform in front of the cars of a cubical water tank on wheels, and replenishing the supply of drinking water on the cars by means of a pump and hose. The regularity of the time as compared with the schedule was perfect. One could set

THE RAILWAYS OF CHINA AND THE ORIENT

ones watch by the leaving time of the train at any of the twenty-five scheduled halting places.

The trip on the ferry steamers between Shimonoseki and the mainland at Fusan, Chosen is a comfortable one. These steamers are maintained by the Japanese government. Their speed is about twenty knots per hour. No cars are ferried from the islands to the mainland, as the mainland railways are standard gage, and the island railways are narrow gage.

The speed of express trains on the Chosen Railways and South Manchurian Railways is 28 miles, per hour, including stops; the speed, similarly for Peking-Mukden express trains is 22 miles per hour. Accidents, with injury to passengers, or loss of life, are unknown.

There are no passenger cars of the Pullman type. However, the first-class coaches on the Peking-Mukden line are divided into compartments, after the English type, and closely simulate the Pullman drawing-room cars of American railways. There are second-class passenger cars, third-class passenger cars; and passengers of the laboring class (coolies) are transported as a sort of fourth class in open freight cars with no seats.

On all of the railways above mentioned English is supposed to be spoken by the conductors and trainmen. However, the English spoken is usually confined to the recognizing of a few set phrases. For example a dining-car attendant will come into the first-class coach and say, "Dinner is now ready." Suppose a passenger asks him "How long a period will dinner be served?" the answer will be, "Yes." Occasionally one meets a conductor who has a good mastery of the English language, even better than that of many Chinese students of English.

Much water has flowed under the bridges since the installation of the first railway in China (1877). This was a little railway running from Shanghai to the port of Woosung. A short time after trains began running a Chinese was run over and killed. The Imperial Government made the accident an excuse for

putting the railway out of business. They bought it from the owners and had the rails torn up. The present Chinese Government, so-called Republican, is not buying railways to tear them up. Quite the contrary. They wish railways built, and have granted many railway concessions.

The railway routes held by concession from the Chinese government are shown on the sketch map of China and its environs herewith, which also shows railways under construction, those in operation, or which have been operated, and routes along which it has been proposed that railways should be built. The railways in operation are paying well. They have all the freight and passenger traffic that they can transport, and their rates for both are high, judged by American standards. The train crews, station men, shop men, clerks, etc., are Chinese and work for low wages. It has been stated, for example, that the operating expenses of the Peking-Mukden Ry. are only 17 per cent of the total annual outgo, including fixed charges, such as interest on bonds.

Nominally, the bulk of the railways in China are under government control. Actually, the European bond-holders have much to say regarding the management, and it is understood that certain of the official positions, rather few, however, shall be filled by the appointment of Europeans. It may be mentioned in passing that the government at Peking has little power. The following states have been in open insurrection for about five years: Kwangtung, Kwangsi, Kweichow and Yunnan. Of late these have been joined by Szechuen and part of Shensi. Within the past month Hunan has been lost to Peking by the capture of Changsha by forces from the South. The Fleet has been in rebellion for several years. So much for the parts of the Republic openly disloyal; although it may be remarked of these that they do not pull together against the government but are divided into at least four factions.

Railroads, Revolution and Banditry

Similarly the parts of the country that are nominally loyal to the government are divided into factions, which are continually squabbling over something or other. Outside of that, the governor of each state maintains an army of his own, usually at least as strong as the whole federal army. Any time it strikes the fancy of a governor to move his troops toward Peking, or elsewhere, he commandeers enough first-class cars and locomotives from the federal railway to serve his purposes, without so much as saying "By your leave." The protests of the members of the European officials, such as traffic managers are of no avail, and the military trains must have precedence over the best express trains.

Another vicissitude of railroading in China is the playful habit of *regular* bandits of swooping down on a train, or on a station, and making off with all the cash in sight; also of carrying off civil engineers, or other members of the staff and holding them for ransom. The usual number of bandits in a group is about one thousand. The number is invariably great enough to overawe any small group of soldiery that may be available. These valiant protectors reserve their fire until the bandits have accomplished their purpose, and are out of range. It is then the custom for the soldiers to make a big show of firing off rifles. In this manner the gallant soldiers persuade themselves that they have behaved in a courageous manner and have frightened the bandits away. It is a favorite custom of winding up a career of banditry to have the local governor or a federal general offer a successful bandit an officer's commission, all of his robber following thus becoming recognized soldiers.

Armies both of the North and the South, during the fighting in Hunan, have laid waste villages, towns and cities. The most powerful governor in all China, Chang tso lin, of Manchuria, is notorious as being an ex-bandit.

Freight Traffic on Chinese Railways

Freight cars, commonly called "goods wagons," after the English fashion, are entirely different from those used in America. To begin with, they are small. Fifteen to twenty tons is a load for the average, and some of them, including coal cars, have a capacity of less than ten tons. They are roofless usually. Trainmen do not travel over the tops of freight trains, as in America. The few cars with roofs have the roofs rounded, without running boards. The goods on the cars are protected from the weather by means of coarse matting. Usually a servant is sent on a car of goods. He protects the car from thieves, maintains the cover of matting, and pays the *likin* tax when the car passes from one province into another. In the usual case a car can not be transferred from one railway to another, and the goods are trans-shipped to another car. The non-transfer of cars is made necessary by there being no standardization of patterns of cars, every line having types of its own. This makes it necessary to keep a car near home so that repair parts may be available when necessary. The mention of the payment of a *likin* tax will be made a text for sketching the general tax situation in North China as applied to the transportation of any commodities from place to place.

In the language of old England of the time of James I, the general attitude of the Chinese governments, federal and state, might be put in a text reading somewhat as follows: *Thou shalt not move commodities from place to place. Lo, it is better that goods should be consumed at the place of origin. But should necessity compel thee in such wise that some small portion of goods shall be transported, then shall such a matter accrue to the benefit of those having dominion over thee.*

Let the reader examine the bill for services paid by the writer to a shipping agency in Tientsin. It is typical of the general expenses connected with the movement of goods. The "case" on which the charges were made weighed perhaps a hundredweight, and the contents cost in Chicago about fifty dollars. At the time the bill was paid the $7.06 charges (Chinese currency) would come to about thirteen per cent of the original cost of the goods. The trans-Pacific freight was prepaid in Chicago.

The import duties are collected by the Maritime Customs service of China, which is invariably managed by a British subject. There are forty-nine ports of entry managed by 7,640 officials, about one-fifth of whom are European; the remainder, Chinese. One of the functions of the Maritime Customs is to distribute lights, buoys, beacons, etc., and to provide for the maintenance of these by collecting tonnage taxes on shipping. Transit dues have always to be paid when goods are shipped from one city to another. This brake on the

wheels of commerce is applied even to small packages going short distances by parcels post. The *likin* tax is the perquisite of the state governors, who are supposed to give part of it to the federal government. "Supposed" is the correct word. There must be a great surplus when the federal government gets anything.

About two years ago the celebrated ex-bandit governor, Chang tso lin, came down to Shanhaiquan to take over some millions of rounds of rifle cartridges and several hundred thousand rifles from a Japanese ship. Ostensibly he did this to accommodate the federal government. So far as the writer is aware, the celebrated Chang is still making excuses as to why he has not delivered the consignment to Peking. He commandeered eighteen first-class coaches from the Peking-Mukden Ry. (June 20, 1920) to take along his bodyguard of four hundred picked soldiers while making a friendly (?) visit to Peking. Perhaps to talk this matter over. Perhaps to suggest to Peking that his countrymen in general are making a great mistake in regarding the Easterners (Japanese) otherwise than as very fine people of the yellow race, who have the very best of intentions with regard to China. He, Chang, lives on the very best of terms with them at Fengtien (Mukden). The governor of Chihli suggests that the *likin* tax in this state should be doubled, as he is not getting sufficient funds to support his soldiery in the style to which they are accustomed.

Coolie Hire and Freight Handling

Coolie hire one has with him always, whenever he wants to move anything anywhere. It is not sufficient that one pay the charges for delivery of goods at the freight shed of a railway. The railway has no anxiety regarding freight handlers. The shipper pays coolie hire to get the goods into the freight car.

Trade is discouraged, further, by the imposition of export duties. These are paid in at least two places: First at the place of origin of the goods, which may be an interior town from which goods are shipped to a large ocean port by river; or it may be a shore port from which goods are shipped by junk or coastal steamer to a deep-water port; second, at the deep-water port when the goods are shipped. *Likin* taxes are paid on goods exported as well as on those imported. If goods are shipped by rail to an ocean port to be transshipped to a steamer, the following would be paid in a typical case: (1) Coolie hire to get the goods out of the warehouse, (2) coolie hire to get the goods to the railway freight house, (3) coolie hire to get the goods in a freight car, (4) export duties (transit dues), (5) *likin* tax, (6) coolie hire for trans-shipping, (7) export duties at the port and (8) shipping agent's charges.

During the summer of 1919 the Peking-Suiyuan, the only really Chinese railway, maintained an automobile passenger and freight service across the Desert of Gobi from Kalgan to Urga. The general route is shown in the accompanying sketch map. Along this route, of about 600 miles, there are no roads worthy of the name. Many of the mountain passes are steep and rocky. No proper system of making repairs to the automobiles was organized. The Chinese chauffeurs were unskilled, and drove recklessly. The outward journey took five days; the return journey, four days. The service did not pay, although the passenger and freight rates were enormously high.

In a previous article (*Engineering News-Record*, April 29, 1920, p. 862) the writer described the roadless condition of China, and showed the insufficiency of railways. Perhaps, aërial transit may help supply the deficiency in means of transportation in the future. There are some signs of the beginnings of aviation. An aërial transportation recently formed in Hong Kong has received from America a consignment of eleven Curtiss hydro-aëroplanes. It is reported that these are to be put on passenger and freight service between Hong Kong, Canton, Macao, Foochow and Shanghai. Some of the machines in the consignment have fuel capacity for 800 miles, carrying ten passengers. There are several privately owned aëroplanes located at Shanghai.

The Chinese government has been assembling and testing six Handley-Page aëroplanes. What the Chinese government will do with its aëroplanes is a matter of doubt. Some Chinese statesmen, like those of other nations, are great talkers. The following propositions have been made in regard to the half-dozen Handley-Pages: That they be used for carrying mails between the larger cities; that they be used for making explorations of a topographical character in connection with railway surveys; that they be used for coast patrols; that they be used for police, or military, duty, such as running down banditti.

Just what to do with the planes at present is only one of the problems confronting the faction-ridden government. As noted in an earlier part of this article, only about half of China is even nominally loyal and little attention is paid to the federal government by the governors of the "loyal" provinces. The Peking government has pledged practically everything pledgeable as security for loans to get money to pay its officials, and is estimated to be running into debt, now, at the rate of $7,000,000 silver (about $5,000,000 U. S.) per month. Truly, to use an apt Americanism, the Chinese government is where its Handley-Pages ought to be . . . It is "up in the air."

[Since the receipt of Mr. McLeod's manuscript, Mr. A. M. Burch of Mineapolis, who recently returned from the Orient, has addressed a letter to us, from which the following is a quotation.—Editor.]

I was disappointed in the amount of engineering work being done in China. Owing to China's great lack of funds, nearly everything of any magnitude has been postponed. I found that the Siems Carey Co. have entirely abandoned their railway building until conditions are more settled and the American International Corporation were marking time on the Grand Canal project, awaiting approval of their plans by their New York office and later by the Chinese government. It is probable that they will start construction on this work within the coming year.

I can see no immediate prospect of further railroad building until some such scheme as the Consortium goes through. There is the greatest need of railroad extension but all the railroads are at a standstill in their construction work, owing to this lack of funds. I found nothing in the construction line going on but the erection of the Rockefeller Foundation, which was the biggest thing in that line I saw. This was a very beautiful series of buildings in Chinese architecture at Peking.

LETTERS TO THE EDITOR

Street Railway Paving Primarily a Tax

Sir—After listening for eighteen years or so to the plaint of the street railway man that he ought to be relieved from the obligation to pave because he is no longer using horses to cause that " 'ard, 'ard 'ammer on the 'ard 'ighway," it was a relief to see the other side of the case set forth so firmly and clearly in your editorial note of Oct. 28, entitled "Street Railways and Pavements." Only the doctrine of economic determinism or class interest can account for the sincerely-uttered belief of many street-railway track engineers that such triflng things as 15-ton to 30-ton (and worse) cars bumping over low joints and shaky special work do not shorten the life of the paving. Whatever may be the case in streets with a discontinuous type of paving, such as block or brick, the veriest tyro can see what the vibrations set up by a heavy car do to the monolithic types of pavement. If my knowledge of this subject is not at fault, one of the principal causes in shortening the iife of monolithic pavement is the entrance of water through fissures. If that is so, the long cracks that may be seen paralleling so many car tracks must be held accountable for a big share of the upkeep bill. As for rail corrugation, a force that can loosen the strongest foundation surely must, and does, affect the paving.

However, I would not undertake to say whether the street railway's responsibility for destruction (not necessarily wear) of pavement is so great as to justify its being charged with maintaining the space between and for 2 ft. on each side of the rails. What the street railway engineer overlooks is that his obligation is primarily a tax; a *quid pro quo*—said "quo" being the franchise, the stipulated rate of fare, etc. An indication that this is so is afforded by the fact that in at least one case the street railway is responsible for all the paving—curb to curb—wherever it operates. Obviously, the obligation to pave all the street is a tax just as Baltimore's park upkeep assessment on the street railways is a tax or the stipulation in one State that 5 per cent of street-railway and motor-bus gross earnings shall go into a school fund. The trouble with the almost universal paving regulation is that it confuses a more or less logical obligation with the revenue needs of the government. The Baltimore park tax and the New Jersey earnings tax leave no room for doubt as to their meaning, for there is no one who would assert that street railways as such wear out public parks or that they should maintain the schools.

A more reasonable argument set up by electric-railway men is that, granting paving is a tax primarily, they ought not to be taxed several times over. Without question, a single all-inclusive tax would be the ideal procedure. Yet who does not know that the history of taxation is one of the seizure of expedients? As one of our oldest utilities, the street railway has gathered unto itself a wider variety of taxes than its juniors. But the lustful eye of Taxation has already been cast upon the youthful motor-bus and motor-truck. If British precedent is to be followed here, as it was in the case of street-railway paving obligations, our automotive friends will have a few grievances of their own. Here is a little story and calculation showing what is going on across the pond:

In 1910 the British Government placed a tax of 6c. a gallon on motor spirit, avowing solemnly that the proceeds were "for the improvement, construction and maintenance of roads in the United Kingdom, and to render financial assistance to the County Councils." A Road Board actually did spend the money as specified until the year 1915. By that time, although the tax had just been doubled (though 6 cents to public-utility operators), the money was diverted to war purposes instead of helping out local road authorities up "to 75 per cent of the net roadway cost." Deprived of this help, the local county councils have had to levy direct road maintenance charges upon public-utility vehicles. Here is the way it works out:

Assume the fair gross earnings of 40c. per bus-mile, consumption of one-sixth gallon fuel per bus-mile and a road upkeep tax of 6c. per bus-mile. Then the fuel and roadway taxes alone will amount to 7/40 or 17.5 per cent of the gross earnings. Add thereto property taxes, income taxes, etc., and we find that 20 per cent of the gross income is chargeable to tax account. Surely no street railway is any worse off than this after two generations of intimacy with the tax-gatherer, whereas the latter is just beginning to get acquainted with the automotive tribe.

The desperate financial plight of most electric railways naturally has led them to seek means to divest themselves of dischargeable tax burdens. The "horseless age" paving argument has been played up most strongly because it sounds so plausible and because paving upkeep is indeed a dread load for them to carry today. It seems to me, however, that it would be a wiser policy to show simply that electric railways are in need of relief. This puts it up to the community to decide how far it is willing to go in the removal of any kind of impost, and even to subsidize the electric railway, as several Massachusetts towns are doing now. Electric-railway operators ought not to put themselves in the wrong on a disputable engineering question when the matter really at issue is the undisputable one that electric railways must have relief—be it through lower expenses or greater income.

WALTER JACKSON,
Consultant Electric Railway Fares
and Service Motor Buses.

Mount Vernon, N. Y., Oct. 31.

Is Surveying a "Trade"?

Sir—I cut the enclosed from a local daily paper. You will note that the U. S. Army, in an advertisement for men, has a picture of two soldiers, one looking through a transit and the other recording notes. Right over their heads are the words in large type "The U. S. Army Teaches Trades."

We have all felt more or less chagrined at times because many people who, we hoped, would know better have classed us in the category of tradesmen rather than professional men. I believe, however, that it will be a shock to members of the profession that officers in the U. S. Army who are

responsible for advertisements for recruits place us, or the surveyors among us, in the category of tradesmen.

Chicago, Nov. 1. A. L. DABNEY, Consulting Engineer.

[Mr. Dabney raises a point on which opinion is decidedly at variance. By some it is held that the land surveyor, from the nature of his work is not justified in assuming the title "engineer." Others classify him as a professional man and not as a tradesman. It is to the point, however, to note that in many of the professional registration acts recently passed a sharp distinction is made between the professional engineer and the land surveyor, and different examinations and licenses apply to the two titles.—EDITOR.]

History's Evidence on Prohibition

Sir—In your issue of Aug. 5, p. 279, H. F. Ammidown requests me to discuss the question: "Have Persia, Greece and Rome stood the test of time so much better than China?" To refresh the recollection of your readers, I will state that the occasion of Mr. Ammidown's question was my assertion that enforced prohibition had caused the degeneration of China.

History records that Ancient Iran, a part of which is now known as Modern Persia, was a powerful empire, and it is readily admitted that Modern Persia is far from that, in fact that it has greatly degenerated. But this same history also shows that the blight of Islam attacked Persia about A. D. 630, Mohammed, its founder, having appeared as a prophet at Mecca about A. D. 610. From A. D. 640 to 642, the empire of Iran went to pieces incident to trouble resulting from Mohammedanism. The foundation stone of Islam may be said to be prohibition of spiritous, vinous and malt liquors (Koran v. 7) (Sura 2, v. 216; 5, v. 92). Prior to the fall of Ancient Iran the Persians used liquors as stimulants, but since adopting the Islam religion, they have used many different kinds of narcotics, producing more opium than they consume and exporting from eight to ten thousand cases annually to China. The only deduction we can make from the facts is that the prohibition of liquor and the substitution of narcotics has been the cause of Persia's decline.

As to Greece and Rome, no one can truthfully assert that any degeneration of the people similar to that in China, Persia and other old prohibition countries, has occurred. The Greeks still use liquors as stimulants and always have. They are a powerful race today, strong physically and mentally, and as an engineer who has employed thousands of them for the past thirty-four years up to within the last year, I can testify that they are good workmen and as clean morally as the best American workmen. No defense of the Italians is needed. They have continued to use wines and other liquors as beverages from the days of the Roman Empire to this day, have continued to progress and from Torricelli to Marconi, have been leaders in engineering. Also the Italian laborer is the best and most efficient worker this country has ever admitted from abroad.

The fall of the Greek and Roman Empires was only such a change in government as must be expected in all countries; the causes are well known and understood, there being no need for repeating them here. The events in past history have left no marks of degeneracy upon the modern Greeks and Latins, as upon the Chinese, Persians and others, who have substituted the use of narcotics for liquors as stimulants.

As regards Mr. Sheibley's communications in the same number, I am glad to admit that China is improving since the younger generation has caused the repeal of the prohibition laws to the extent of not only permitting but encouraging the establishment of breweries and wineries in China. With the introduction of mild stimulants, like light wine and beer, it is hoped that the Chinese will be redeemed. When this has occurred it will be time enough to admit them to fellowship with the American "home brewers."

Los Angeles, Cal., Oct. 27. F. C. FINKLE, Consulting Engineer.

Information on Deterioration of Slag Concrete Wanted

Sir—In connection with researches on concrete aggregates which are being carried on by the Committee on Aggregates of the American Concrete Institute and Committtee C-9 of the American Society for Testing Materials, information is desired by the writer of any instances of concrete made with slag as a coarse aggregate which have shown any signs of deterioration with age.

It is requested that full information be given as to the conditions of laying, character of sand, proportions, kind of cement used, whether portland, natural or puzzolan, and the age of the concrete. If samples of concrete are available they may be forwarded for inspection. If it is desired that the information be kept confidential this should be stated in writing, addressing me at 136 Federal St., Boston.

Boston, Mass., Nov. 6. SANFORD E. THOMPSON, Chairman Committee on Concrete Aggregates, American Concrete Institute.

Methods and Results of Iowa Impact Tests on Highway Bridges

Sir—A letter of J. H. Ames, of the Iowa Highway Commission, calling attention to the impact tests made by the commission in 1912 appears in your issue of Oct. 21, 1920. As I alone proposed and made these tests for the commission I feel that it is my duty to give sufficient facts at this time regarding these tests to acquaint engineers in general with the results actually obtained, although the results are referred to in my "Structural Engineering" and are well known to some of the highway commissions, particularly the Illinois commission.

I obtained four impact instruments from the American Railway Association; these instruments had been used by Professor Turneaure and a committee in making tests for the Association to determine impact in railroad bridges due to railroad loading, which of course consists of locomotives and trains. I started out making tests on highway bridges following the instructions given me by the railroad people and using live loads consisting of trucks and traction engines.

Considerable impact was indicated by the instruments in the members of light ordinary highway bridges supporting wood floors. After a little practice in the work the question occurred to me as to how much of the movement of the needle of the impact instrument was due to actual impact and how much was due to vibration. So I decided to back up and make a thorough investigation of the instruments and determine independently the stress constants of each instrument and also, if possible, determine the amount of the movement of the needle due to vibration and the amount of movement of the needle due to actual impact.

By clamping an instrument onto an angle bar and vibrating the bar when there was no stress in the bar extensive movement of the needle was obtained, which no doubt was due solely to vibration. This experiment showed that the movement of the needle of the impact instrument due to vibration of a bridge member could easily be confused with the movement of the needle due to impact. Next, an instrument was clamped onto a bar having a known modulus of elasticity and the bar was placed in a testing machine. The actual stress in the bar was given by the testing machine and the stress indicated by the impact instrument was obtained. The discrepancies of the impact instruments were obtained in this way and constants for correcting the stress reading of the impact instruments were determined, as just explained. Then, loads were applied to the bar suddenly and the movement of the needle due to impact was recorded. Next, by jarring the bar during the application of the same suddenly applied load (knowing the correct stress for the static load and the movement of the needle due to vibration) the movement of the needle on the instrument due to impact was fairly well isolated from the movement due to vibration.

After these preliminary investigations of the impact instruments were completed tests were made to determine impact in practically all kinds of bridges throughout Iowa due to practically all kinds of loading. It was found in the case of bridges having concrete floors that automobiles (having pneumatic tires) produced no impact at all. Traction engines and trucks produced but very slight impact, while in the case of light bridges with wood floors the impact did not exceed 10 per cent of the static stress in any case although the live load included fairly heavy trucks speeded up to 15 miles per hour.

In the case of a drove of cattle passing over a bridge very severe vibration was indicated by the instruments, yet very little impact occurred, due no doubt to the fact that th cattle had never had military drill.

Prof. F. O. Dufour, formerly of the University of Illinois, A. N. Johnson, formerly State Engineers of Illinois, and myself, I believe, were first to investigate impact in highway bridges.

As consulting engineer for the Iowa Highway Commission it was my duty to select loadings and develop the designs of the highway bridges in that state, which I did with the exception of the culverts. I made a very thorough investigation of live loads before the present live load was selected. At first an imaginary impact stress was provided for but was ignored after I had made some careful observations, and was literally forgotten after the impact tests extending over a period of several months were made.

The tests made in Illinois by Prof. Dufour and Mr. Johnson and the tests I made in Iowa should have been fully published. But the Illinois and Iowa commissions seemed to be about the only parties interested in impact on highway bridges at that time. I offered to write a bulletin covering my work on impact but funds were not available at that time. The authorities in Illinois and Iowa were satisfied that impact should be ignored and that seemed to be all that was necessary. For the benefit of those desiring to investigate impact I wish to submit the following for consideration:

Concrete bridges and steel bridges carrying concrete floors are subjected to very little impact, due to the fact that the inertia of the structure must be overcome before impact affects the stresses in the structure.

The case of railroad bridges is entirely different from that of highway bridges. In the case of railroad bridges the nosing of the train which is continuously applied as the train passes over the structure and the hammering due to the counter-weights, which is also continuously applied as the train passes over the structure, cause accumulative impact. There is no case where a highway bridge will be subjected to accumulative impact. The case of a chuck hole in a concrete floor on a highway bridge has been mentioned as the cause of heavy impact. One chuck hole in a highway bridge floor would not cause accumulative impact. A wheel striking such a chuck hole would cause an impact directly on the floor but the inertia of the floor and the bridge would absorb the blow and mostly vibration would result. If there were several chuck holes in the floor of a highway bridge spaced at a critical distance apart and a critical load passed over this improbable floor at a critical speed impact probably would be produced to quite an extent. But no doubt the live load would be wrecked in the meantime.

I have designed hundreds of highway bridges and have seen thousands, but I have never found a serious chuck hole on a bridge carrying a concrete floor.

The tests made by the Bureau of Public Roads are of value in so far as they apply to pavements. We all emphasize the importance of maintenance of all types of pavements, while the public demands maintenance of bridge floors. The officials' attention would be called to the condition of the floor very forcibly before a floor would get into such a bad condition that impact would be of importance.

J. E. KIRKHAM, Bridge Engineer,
Pierre, S. D., Nov. 2. South Dakota Highway Commission.

Inclined-Bearing Tests and the Howe Formula

Sir—The writer has read with interest the comments of H. D. Dewell in your issue of Oct. 21, 1920, p. 811, on the test methods used in determining the crushing strength of Southern pine at angles to the grain.

It is not conceded that the typical joint illustrated in Mr. Simpson's article (Sept. 30, 1920, p. 654) is universally the most economical form to use, for by a slight rearrangement of the cutting planes in his notch it is possible to reduce the effective force in the strut to its horizontal component. Moreover, if we increase the values as given by the Howe formula by an allowance for shear, and also take into account the shearing resistance of the connecting bolts, I see no reason why practically any joint should not be feasible whose design is based on the Howe formula.

As safe shearing values for timber have been generally established, it seemed wise to the writer to eliminate shear as much as possible from the tests in order that data on simple crushing strength of inclined faces might be built up. In this manner we will be enabled to deal separately with each phase of a given design problem, and thus tend to clear up the existing situation. At best, qualities of wood are extremely variable, even in the same species.

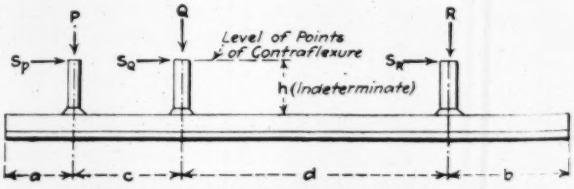
It is admitted that the basis of the Howe formula is different from that of the Southern pine tests; but it is also contended that an apparent agreement between the two graphs, plotted between the same terminal values, constitutes a fortunate and labor-saving coincidence. If we consider the Howe formula, regardless of its origin, as a general expression of the law of variation in Southern pine, we then have a satisfactory equation for use which is doubtless less complicated than any original one which could be devised.

The writer hopes to see the work go on, especially along the lines indicated in the last paragraph of Mr. Dewell's letter.

Q. C. AYRES,
Ames, Iowa, Iowa State College.
Oct. 27.

Effect of Column Base on Theory of Continuous Foundation Girders

Sir—Prof. Ellis' discussion of the continuous three-column foundation in *Engineering News-Record* of Oct. 7, 1920, is interesting and suggestive. I find, however, that the equations therein developed are applicable only to the case in which the columns have base shoes with pins, thus eliminating column moment. Referring to the figure accompanying this letter, it is clear that without pins the only case in which the shears S_p, S_q and S_r would be zero is that in which the neutral axes at P, Q and R remain horizontal.



THREE-COLUMN FOUNDATION AFFECTED BY COLUMN SHEARS

This is a very special case. Also the column conditions at the story above may be such as to cause moment to be be transmitted to the foundation girder. I think the case is susceptible of a solution which would be closely approximate, but I doubt whether in most offices the cost of computation would not exceed the saving of material. It would be useful, however, to have several type-cases computed as a guide for the designer in proportioning the projections of the foundation girder.

ALBERT SMITH,
Professor of Structural Engineering,
Lafayette, Ind., Oct. 18. Purdue University.

Ancient and Modern Direct-Process Irons Identical in Composition

Sir—I have read the interesting article "Direct-Process Native Furnace Iron Like Metal in Delhi Pillar," published in *Engineering News-Record* of Oct. 21, 1920, relating to a paper on the primitive method of wrought-iron making as actually practised in India in the proximity of modern steelworks, read by Andrew McWilliam before the British Iron and Steel Institute. This instance of the oldest metallurgical method of iron-making being in operation besides modern steelworks is not unique. In several of the Mediterranean countries, wherever the cost of labor and the abundance of charcoal allows it, the Catalan process survives to a small extent. The Catalan, Corsican, and Elba processes are chemically identical with the direct methods of iron-making still in use in India, Burmah, Africa and other regions where modern methods have not yet penetrated. In a few places the furnaces work with natural draft; in others, native iron-makers use bellows and a variety of blowing appliances, such as the hydraulic blowing machine known as "trompe," which provide the blast for the Catalan and similar forges used in Europe.

The production of direct-process wrought iron and of steel in the forge has in our days only historical interest; the few examples remaining will gradually disappear through the introduction of modern methods. It will be interesting to note in this connection that metal almost of the same composition as that of the direct-process furnace has been produced in open-hearth practice, which showed: Combined carbon 0.060, silicon 0.040, sulphur 0.047, phosphorus 0.032, manganese 0.100 per cent.

The practice of wrought-iron making in the Indian forge is the same now, as it was in the first millenium B. C., and before. So also the grade and preparation of the iron ore reduced. All things being equal, the composition of the resulting material must be exactly the same. This is confirmed by the similarity of analytical composition of the metal forming the other two iron columns existing in India besides the Delhi Pillar: the column of Dhar in the Central provinces, and that of Konarak in Orissa. Numerous specimens of direct-process iron found in Ceylon are also analogous in composition.

New York City, Nov. 1. BAXERES DE ALZUGARAY, Consulting Chemist and Metallurgist.

Strength of Concrete Made From Large Size Aggregate

Sir—The article in *Engineering News-Record* Sept. 30, 1920, describing the use of 6 in. bank run aggregate in the construction of the Stevenson dam emphasizes our lack of knowledge of the effect of such oversize material on the compressive strength of concrete, and brings up several important points in testing practice which should be given consideration by testing engineers. No doubt the use of oversize aggregate will prove economical and satisfactory in many cases where adherence to the usual 1½ in. maximum size results in extra expense for the handling of the rejected material, but the true strength values of the concretes should be known.

Tests with which the writer is familiar have shown that a 1½ maximum size aggregate containing a high percentage of the larger particles may be so grouped in a 6 by 12-in. cylinder as to result in a wedging action which considerably lowers compressive strength. The use of 2½-in. aggregate in a 6-in. cube no doubt gives lower strength values and greater variation in individual test results. Tests have also shown that specimens made with that portion of the batch of mixed concrete passing the ¾-in. screen will run from 75 per cent to 100 per cent stronger than other specimens from the same batch in which particles up to 1½ in. are retained. The test results of the Stevenson dam concrete are probably the same amount higher than those which would have been obtained had sufficiently large test pieces been molded to include the aggregate up to 6 in. Such specimens should have a minimum cross-section of not less than 450 sq.in., in the form of a 24-in. cube or a cylinder 24 in. in diameter. Specimens of such size are very heavy and difficult to handle, and there are few testing machines with sufficient clearance between the vertical screws to accommodate them.

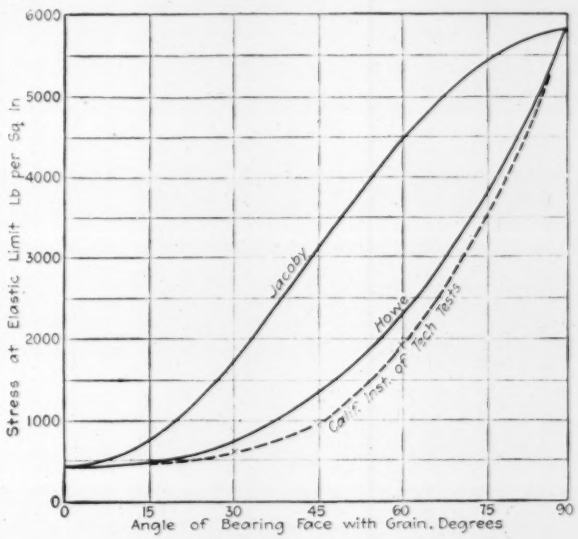
The main point to be emphasized is that tests made on small specimens from which the larger particles of the batch have been rejected will furnish results far too high, and that regardless of any other conditions of the test the quantity of cement in a unit volume of concrete is an important factor which should not be disregarded in interpreting the test results.

Saskatoon, Sask., Oct. 8. G. M. WILLIAMS, Professor of Civil Engineering, University of Saskatchewan.

Tests of Bearing Strength of Redwood Agree with Howe's Formula

Sir—In connection with the two articles on the crushing strength of wood at various angles to the grain which were published in *Engineering News-Record* of Sept. 30, 1920, the following results of tests made on redwood at the California Institute of Technology during the past year may be of interest.

The specimens tested were 1¾ x 1¾ in. in cross-section and 3 in. long, cut from clear stock so that the grain of the five



INCLINED-BEARING TESTS ON REDWOOD

tests pieces made angles of 0°, 30°, 45°, 60° and 90° with the bearing faces. A 30,000-lb. Olsen testing machine was used and the deformations for successive increments of load were read on dial gauge compressometers. The elastic limit for each specimen was determined from stress-strain diagrams drawn from these data. As was anticipated, all the speciments except those in end bearing and cross bearing failed in shear.

TESTS OF CALIFORNIA REDWOOD IN COMPRESSION AT VARIOUS ANGLES TO GRAIN

Angle of Bearing Face with Grain	Compressive Stress at Elastic Limit—Lb. per Sq.In. Set 1	Set 2	Set 3	Set 4	Set 5	Aver.	Allowable Stress by Formula of Jacoby	Howe
90°	5,800	6,500	6,000	5,730	5,000	5,806	5,806	5,806
60°	1,680	2,250	2,370	1,910	1,260	1,894	4,452	2,350
45°	1,000	940	1,050	820	920	946	3,098	1,350
30°	450	840	670	630	545	627	1,744	740
0°	350	440	410	365	390	391	391	391

The accompanying curves, plotted from the above data, indicate that for redwood Howe's formula gives values more nearly in accord with the experimental data than does Jacoby's.

R. R. MARTEL, California Institute of Technology.

Pasadena, Cal., Oct. 24.

NEWS OF THE WEEK

New York, November 11, 1920

Discount on Water Bills Must Be Stopped by Company

In granting a new schedule of rates to yield 8 per cent on a valuation of $266,165 and $15,394 for current expenses, the Railroad Commission of California, in a ruling announced Oct. 13, ordered the Pasadena Consolidated Water Co. to discontinue its practice of allowing 10 per cent discount on water bills paid before a stated date. The commission declared that a water company can protect itself against bad bills by rules and regulations. The company supplies water for domestic use and irrigation in the vicinity of Pasadena. A similar ruling was made in another state not long ago.

Approval by Voters of Public Works Bond Issues is Countrywide

Billions of Dollars Provided for Construction of Roads, Water-Works, Tunnels and Other Public Improvements — Few Projects Defeated

Returns from all sections of the country indicate a sweeping approval by voters on Nov. 2 of bond issues for public works construction. There follow details of some of the more important projects for which funds were voted:

Baltimore Votes $51,750,000 of Bonds—Baltimore's four big municipal improvement loans (providing for expenditure of a total of $51,750,000 on new schools, sewers, streets and bridges, conduits, harbor and water-supply betterments and a new municipal hospital) were each ratified by majorities in excess of 150,000. (See *Engineering News-Record*, Oct. 28, 1920, p. 866, for further details.) Plans for floating the bonds are to be taken up at a joint meeting of the Public Improvement Commission and the Commissioners of Finance, shortly to be called by William F. Broening, mayor of Trenton. The bonds are to bear interest at 5 per cent.

Construction operations are to start in the early spring, and the advertising for sale of sufficient blocks of securities to cover initial outlays on the work may be expected in January or February, although the officials will be guided in large measure by market conditions, deferring action to await a favorable market. Bids are to be submitted to the Municipal Board of Awards, Mayor Broening, president.

Members of the Public Improvement Commission, to have charge of the expenditure of $41,000,000 of the total, took the oath of office Nov. 4, and the members of the Port Development Commission, to supervise the expenditure of $10,000,000 on harbor improvements, qualified Nov. 8. The members of the commissions are: (1) Public Improvements: Robert Garrett, of Robert Garrett & Sons, bankers, Garrett Building, chairman; Jacob Epstein, Judge Henry D. Harlan, former Mayor J. Barry Mahool and William Kalb. (2) Port Development: John E. Greiner, of J. E. Greiner & Co., consulting engineers, Fidelity Building, chairman; Austin McLanahan, Benjamin F. Woelper, Jr., former Mayor James H. Preston, and Elmore B. Jeffery. The hospital loan will be expended under the direction of the Municipal Board of Estimates.

Hudson River Tunnel and Delaware River Bridge Bonds Carry—The $28,000,000 New Jersey bond issue for a vehicular tunnel beneath the Hudson River between New York City and Jersey City and for a bridge over the Delaware River between Philadelphia and Camden was carried by a heavy majority. Full returns are not available, but it is believed that every county in the state indorsed the project. The majorities in Essex, Hudson, Passaic and Union Counties, opposite New

Civil Engineers Refuse To Join Federated Engineering Societies

In Record Total of 5,608 Ballots Proposal To Enter New Organization Is Defeated by Margin of Almost 1,000 Votes

By a vote of 3,278 to 2,330 the American Society of Civil Engineers, in the letter ballot canvassed Nov. 8, defeated the proposal to become a member of the Federated American Engineering Societies. The total vote of 5,608, analyzed by districts in the accompanying table, exceeds by almost 1,000 the heavy balloting recorded Oct. 6 on the constitutional amendment questionnaire and reported in the news section (p. 767) of this journal Oct. 14.

AMERICAN SOCIETY CIVIL ENGINEERS VOTE ON PROPOSAL TO JOIN THE FEDERATED AMERICAN ENGINEERING SOCIETIES

District*:	1†	1‡	2	3	4	5	6	7	8	9	10	11	12	13	Total
Yes	24	272	153	101	311	192	239	223	144	115	122	192	111	131	2,330
No	31	792	290	198	192	224	237	148	356	221	172	149	122	146	3,278
Total	55	1,064	443	299	503	416	476	371	500	336	294	341	233	277	5,608

* Dist. 1, N. Y. City and foreign; Dist. 2, New England States; Dist. 3, N. Y. State and Quebec; Dist. 4, Eastern Penn., Md., N. J., Del.; Dist. 5, D. C., Va., N. and S. C., Ga., Fla.; Dist. 6, Western Penn., W. Va., Ohio; Dist. 7, Ontario, Mich., Wis., Minn., Manitoba, Ia.; Dist. 8, Ill., Ind., Ky., Tenn.; Dist. 9, Ala., Miss., La., Ark., Mo.; Dist. 10, Okla., Kan., Col., Utah, Neb., Wyo., N. and S. D., Mont., Saskatchewan and Alberta; Dist. 11, Tex., Mex., Ariz., S. Cal.; Dist. 12, B. C., Idaho, Wash., Ore., Alaska; Dist. 13, Northern Cal., Nev.

† Foreign. ‡ Resident.

The federation project was defeated this week in nine of the society's thirteen districts, affirmative majorities being returned only from Districts 4, 6, 7 and 11, covering the Pennsylvania-Ohio, the Great Lakes, and the Southwest territories. By far the largest negative plurality was rolled up in the New York district (No. 1) where the "No" votes totalled 792 against only 272 "Yes" ballots. In District 6 (Western Pa., W. Va., and Ohio) opinion was almost equally divided, there being 239 negative votes and 237 affirmative. The western states, contrary to predictions that had been current while the ballot-

federation. In addition to arguments pro and con, prepared by special committees named by the society's Board of Direction and circulated in printed form to the corporate membership, additional appeals carrying long lists of signatures were distributed.

The action of the American Society of Civil Engineers comes almost on the eve of the first meeting of the American Engineering Council, the governing body of the Federated American Engineering Societies, which is to convene at Washington, D. C., Nov. 18 and 19. All of the other founder societies—mechanical, electrical and mining—have already become charter members of the federation, in addition to a score or more of city, state and regional organizations.

York City, were large, while in Mercer County, the center of the state, a majority of 3,000 votes was recorded. If the bonds had not carried the cost of the two projects might have been met by direct taxation. Under the terms of the bond authorization act tolls will be charged for the use of the tunnel and bridge in order to meet the bond and other charges.

Newark Votes for Municipal Light and Power—By a vote of 35,814 to 34,165, Newark, N. J., voted for the establishment of a municipal light, heat and power plant. No plans have been made or money provided for the project. Charles P. Gillen is mayor.

Large Loan at Philadelphia—A $33,000,000 loan for municipal improvements was authorized.

Harrisburg Votes Water Bonds—A $1,600,000 loan for water-works improvements at Harrisburg, Pa., was authorized. (See p. 963 for details.)

St. Paul Votes Water Bonds and Charter Amendments—A bond issue of $4,000,000 was voted by St. Paul, Minn., for the construction of a filter plant, service reservoir, pumping plant, and reinforcing water mains to remedy low pressure in portions of the city. The present supply is from lakes north of the city and artesian wells. The new supply will probably be taken from the Mississippi River north of the city. John W. Kelsey is superintendent of the water department.

The charter of St. Paul was amended (1) to permit levying a wheelage tax for construction and maintenance of pavements and (2) to permit charging to abutting property owners the cost of a 12-ft. strip of new pavements in place of having all the cost met by benefit assessments.

Road Bond Amendments Carry

Missouri City Bond Limit Increased—A constitutional amendment allowing Missouri cities of 100,000 and over (St. Louis and Kansas City) to raise the limit of bonded indebtedness from 5 to 10 per cent of their assessed valuation probably carried, there being a favorable majority of about 130,000 in St. Louis, Kansas City and St. Joseph, which it is thought can not be overcome by the smaller cities and rural districts. This amendment was particularly desired by Kansas City to enable it to improve its water-works (see *Engineering News-Record*, Oct. 28, p. 865).

Minnesota Ratifies Babcock Good Roads Amendment—Minnesota ratified Constitutional Amendment 1, popularly known as the Babcock Good Roads Amendment, whereby a state system of paved roads, 6,900 miles in length, connecting all county seats and other towns of over 1,500 population, and sufficient funds for the proper construction and maintenance of such a system, are provided. No time limit is set as the date for completion of the system, neither is it specified what maximum financial obligation may be incurred, with the exception that not more than $10,000,000 in bonds may be issued in a single year or more than $75,000,000 be outstanding at any time.

West Virginia Votes Ten to One for Road Bond Amendment—By a vote that is estimated as 10 to 1 West Virginia ratified a constitutional amendment providing for the issuance of $50,000,000 in bonds for construction of a system of highways connecting county seats.

Missouri Road Amendment Apparently Carries—The heavy vote in cities is expected to give a large majority in favor of Constitutional Amendment 6, authorizing the issuance of $60,000,000 in bonds for highway construction under state supervision. Early estimates put the majority by which the amendment will be carried at 100,000. Rural districts, the last to report returns, appear unfavorable to the proposed amendment. Incomplete returns from 29 counties give the amendment a majority of 49,612, and complete returns from 17 a majority of 4,186.

One Possible Road Bonds Defeat

Carlyon Bill Apparently Defeated—Washington State's proposed constitutional amendment, whereby bonding of the state for $30,000,000 for 20 years, bonds to be retired through revenue from motor vehicle licenses, was apparently defeated. The proposed amendment was known as the Carlyon Bill. Incomplete returns from Seattle and from King County showed 26,000 votes for and 35,000 against the amendment.

Georgia's "Baby Bond" Amendment Passes—A constitutional amendment authorizing the issuance of 10-year bonds for street paving by cities in Georgia of more than 150,000 population passed. It is agreed that a great amount of municipal street work will be done during 1921 because of the new amendment, Atlanta alone contemplating the issuance of bonds to the amount of $5,000,000. The amendment was popularly called the "baby bond" amendment.

County Votes $1,000,000 in Highway Bonds—Susquehanna County, Pa., voted to issue road bonds to the amount of $1,000,000. The majority was 1,123, though some 3,000 voters failed to vote on the bill.

Alabama County Votes Road Bonds—The majority in favor of bonding Morgan County, Ala., in the sum of $440,000 for road improvement is expected to be around 600, early returns indicate.

State Railway Tunnel Bonds

Colorado State Railway Tunnel Bonds Probably Carried—Incomplete returns indicate a favorable vote on the amendment to the Colorado State constitution authorizing a bond issue of $18,550,000 for the construction of three tunnels through mountain ranges to improve the transportation service of districts now almost isolated and also to improve through traffic facilities by giving lower grades and avoiding present open summits at high elevations where snow troubles are serious. The six-mile Moffat tunnel on the Denver & Salt Lake R.R. is estimated to cost $7,517,936; the six-mile Monarch tunnel on the Denver & Rio Grande R.R., $7,348,400, and the 1½-mile San Juan R.R. on another line of the latter road, $3,538,397, a total of $18,404,730. These tunnels are to be owned by the state and leased to the railroads, the law requiring the latter to make use of the new facilities provided. A description of this project was given in *Engineering News-Record* of April 8, 1920, p. 716.

Bridge Bonds Approved

Wayne County Bridge Bonds Voted—The construction of two bridges across the Rouge River at Detroit, Mich., was authorized by the voters of Wayne County—one at Fort St. and one at Jefferson Ave.

Some of the Favorable Results in Ohio—Votes in favor of municipal improvements were cast in a number of Ohio cities. Some of these were: *Akron:* $2,000,000 voted for parks; $250,000 for approaches to the North Hill viaduct.—*Ashtabula:* $1,000,000 for a new light and power plant.—*Marion:* $525,000 for storm sewers defeated, but a tax levy proposed for a $1,000,000 outlay for sanitary sewers and sewage treatment was carried.—*Sandusky:* $244,000 for resurfacing downtown streets.

Chicago Votes Park Bonds—A $1,000,000 bond issue for the extension of Lincoln Park was voted at Chicago. Most of the work will be done by day labor.

Leavenworth to Buy Waterworks—A vote of nearly 2 to 1 was cast to buy the property of the Leavenworth and Ft. Leavenworth Water Co. Bonds will be issued to pay for the plant which a board of engineers recently appraised at $650,000.

Topeka Votes Water Bonds—A total of $535,000 water bonds was voted. A filtration plant will be built after plans by C. A. Haskins, Lawrence Kan.

Some Adverse Votes

Two Bond Issues Defeated at Louisville—A $500,000 war memorial and auditorium loan and a $1,000,000 loan for the University of Louisville failed to receive the necessary two-thirds majority at Louisville, Ky.

Franklin County, O., Votes Against Bridge Bonds—A county bridge bond issue was defeated by 8,816 votes, according to reports from Columbus, O.

Sandusky Votes Down War Memorial—For the second time the voters of Sandusky, Ohio, defeated a proposed $250,000 bond issue for a soldiers' memorial building.

Toledo Prefers Service at Cost to Municipal Railway—A service-at-cost street railway ordinance was carried at Toledo, Ohio, by a vote of 46,000 to 18,000. By somewhat lighter total vote, of about the same ratio, but inverted, a $4,000,000 and an alternative $3,000,000 bond issue ordinance for municipal ownership were defeated.

Flexible Interest Rate To Aid California Road Bond Sales

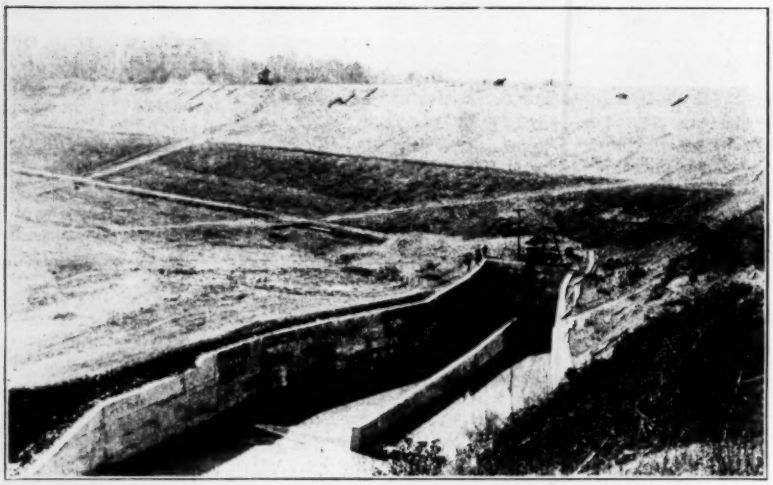
At the election on Nov. 2 California voters approved a measure providing for a flexible interest rate on highway bonds, and the means for adjusting that rate to suit market conditions. This measure, which was strongly supported by the state highway commission, is expected to expedite materially the financing of state highway work. It will distribute more equitably highway costs and will relieve the highway commission of the necessity of getting counties to pay the difference between the par and market values of bonds used for road work within their boundaries.

Under the new plan there is created a state highway finance board consisting of the governor, controller, treasurer, chairman of the state board of control, and chairman of the state highway commission, all serving without compensation or expense. When a block of highway bonds is to be sold this board is to investigate market conditions and fix a rate of interest, not exceeding 6 per cent, such that the bonds can be sold at par.

The second part of the measure relieves counties of the payment of interest on state highway construction within their boundaries a requirement that has been in effect since the state highway commission was organized. That provision was included in the original plan because it was presumed that the roads would be of more value for local than for through traffic. It has been found, however, such a plan makes an unfair distribution of the burden. In constructing trunk-lines and laterals by the most direct routes, and with what the highway commission calls "the phenomenal development of through traffic, both passenger and freight," local traffic on most state highways is now but 25 per cent of the total. Moreover, some of the most expensive construction was through counties having a small assessed valuation — Mono County was raising 48c. on the $100 to pay state highway bond interest while San Francisco paid nothing at all.

Germantown Dam Completed

Last week the embankment of the Germantown dam of the Miami Conservancy District, about 10 mi. northwest of Dayton, Ohio, was completed, the officials of the district advise. Work was at once started on placing the permanent floor in the twin outlet conduits, which will reduce the conduits to half their initial height; to carry the flow of freshlets during construction and to reduce the depth of ponding back of the uncompleted embankment, the conduits were built of twice their design depth, and have served during the past year in this condition. The final floor, now being built, is at half the height of the conduit opening, and the space below is to be filled when flow has been diverted to the new floor. It is expected that this work and all necessary finishing operations at Germantown will be completed this season.



GERMANTOWN DAM, FIRST OF MIAMI CONSERVANCY DISTRICTS' FIVE FLOOD CONTROL DAMS TO BE COMPLETED

As the Germantown dam is the first of the District's five dams to be completed, the present stage represents an important step in the progress of the Miami Valley flood protection. The dam will be ready for full service in the coming spring floods, and by exerting its full detention action (the double-size conduits were in service during the 1920 high water) it will contribute its intended share toward reduction of floods in the lower part of the valley.

Work on the dam began in spring of 1918 and has progressed according to schedule and without mishap. The dam is 110 ft. high and contains about 900,000 cu.yd. of embankment, most of it placed by hydraulic sluicing. Arthur L. Pauls, division engineer, and Albert Armstrong, superintendent, are directly responsible for the conduct of the work.

One Indicted in Building Graft Inquiry

Lockwood Committee Probe Discloses Transfer of $25,000 by New York Contractor to Call Off Strike

The indictment of George S. Backer, a New York City contractor, on the charge of perjury in connection with his testimony; the cancellation of New York County courthouse contracts because of indications of collusion in bidding; and the possibility of further indictments, and contract cancellations by the city on school and other work, are the recent outstanding features in the building graft inquiry being conducted by the Lockwood Joint Legislative Committee on Housing being held at the City Hall, New York City, with Samuel Untermyer as counsel for the committee.

Mr. Backer, who has been operating in New York City for years, acted as a go-between in the transfer of $25,000 from the contractor for whom he was acting as superintendent of construction, and two walking delegates. The money was paid to call off a strike but Backer first testified that he had gambled the money away at the racetrack and in playing cards. When cross-examined he admitted having paid the money to two "strangers," who, he understood, were acting as agents for Robert P. Brindell, the "king" of the New York building labor world. Backer was arraigned before Judge Mulqueen, of General Sessions, Nov. 8, having previously been released after arrest on $25,000 cash bail.

The cancellation of the contract for furnishing cut limestone for the New York County courthouse came as a result of the testimony offered by Henry Hanlein, who had been awarded the contract, in which it was intimated Hanlein was to be the only bidder as a result of a conference and an agreement among the cut limestone producers in New York City.

Investigations are under way both by the Lockwood committee and the New York Board of Estimate and Apportionment into the presence of irregularities in the award or prosecution of school and other contracts for the City of New York, involving the expenditure of approximately $60,000,000.

Purchase of Fifty-Two Snow Plows Advised by Highway Engineer

In order that the New Jersey State Highway Department may not be short of equipment with which to keep main trunk-line routes open to traffic throughout the winter, Thomas J. Wasser, state highway engineer, at a recent meeting of the Highway Commission recommended the purchase of 52 additional snow plows. The Department already owns 22 plows. It is understood that the Highway Department will soon receive proposals for the supply of the needed plows.

Southern Power Co. Will Build New Station

Plans are being prepared by the Southern Power Company for the construction of a new 60,000-kva. water-power plant near Charlotte, N. C. This will be the ninth hydro-electric plant to be tied into that company's system of 2,050 miles of high-voltage transmission lines and brings the total rating of its hydro-electric and steam stations up to 340,900 kva. The new station will be laid out for four units, operating under a head of 85 ft. It will be of the usual type of construction adopted by the Southern Power Company. The dam and power house will require about 250,000 yards of masonry. Preliminary specifications for the four waterwheels have been sent out to the manufacturers. W. S. Lee, vice-president and chief engineer of the Southern Power Company, states that the plans for the new station call for its completion in the summer of 1922.

Hetch Hetchy Cost-Plus Contract Is Valid—Work Resumed

The supreme court of California has decreed that nothing in San Francisco's charter prevents the city from entering into a contract on a cost-plus fee basis such as that made with the Construction Company of North America for driving 18 miles of tunnel on the Hetch Hetchy project. The validity of the contract was challenged in a taxpayers' suit filed last May and which placed an injunction on the payment of $276,776, the initial fee due the construction company.

Work on the tunnels was shut down on Aug. 26 by a strike of the tunnel workers, and, pending the outcome of the suit over the contract, was not resumed. With the favorable decision of the court, however, new crews have been brought in and, beginning Nov. 1, the several headings are all being worked.

Rex Starr, sub-contractor for the 8 miles of tunnel on the upper end, has assigned his contract to L. DeLucca. Contract for the 10 miles on the lower end is held by A. C. Dennis.

At the main Hetch Hetchy dam the Utah Construction Company has excavated both abutments from crest level down to water level, opened quarries, built tracks to bunkers, crushers and screens and installed another incline, with a capacity of 40 tons, down to the floor of the valley. The entire foundation of the dam is expected to be exposed, and concrete pouring under way within four months.

New Railway Survey in Manitoba

The Government of the Province of Manitoba has granted authority to the Canadian National Rys. to proceed immediately with a survey for a new line from The Pas to the Flin Flon mining area, about ninety miles northward.

Mississippi River Traffic Held Up For Terminals

(Washington Correspondence)

While two of the new power boats and several of the modern barges built for the Mississippi-Warrior River barge lines have been delivered, Brig.-Gen. William D. Connor, in charge of inland water transportation for the War Department, states that the experiment, so far as operation on these rivers is concerned, cannot really begin until next spring. The full new equipment, it is expected, will be delivered during the winter. Thus far the barge lines have been conducted with makeshift equipment which has literally been wracked to pieces. Operation with that plant, Brigadier-General Connor points out, is in no way indicative of what can be accomplished with equipment especially designed for use on the Mississippi and Warrior Rivers.

Those connected with the barge line experiment feel that the perfection of operation is only a matter of time and that the really important part of the experiment has been successfully concluded—the determination of the fact that tonnage is available in sufficient quantity to justify the operation of these lines. Despite the uncertain service, there never has been a time since the Mississippi barges have been operated that there has not been a superabundance of freight.

Under present conditions the cost of handling freight at terminals is excessive. It averages between $1.25 and $1.50 at St. Louis. The average at New Orleans is slightly less. Plans for the establishment of well equipped terminals are now being perfected. Plans for the terminal at Mobile have been completed and are now in the hands of contractors who are studying them. The plans for the Memphis terminal are well advanced and some work has been done on a plan for improved terminal facilities at New Orleans. It is the intention to develop terminals at Vicksburg, Cairo, and East St. Louis and greatly improve the terminal at St. Louis. A modern coal-loading plant will be established at the head of navigation on the Warrior River.

Water-Works Improvements for Harrisburg, Pa.

Recommendation for improvements and extensions to the water supply of Harrisburg, Pa., made recently by James H. Fuertes, consulting engineer, New York City, are estimated to cost about $1,500,000. The largest single item is $530,000 for a 30,000,000-gal. high-service reservoir. Among the other large items are $270,000 for a new sedimentation basin, six new filters, a 15,000,000-gal. pump, and boilers at the filter plant; some $300,000 for removal of pumps built in 1874, and provision of new pumps; and $285,000 for new water mains. A water bond issue of $1,600,000 was voted Nov. 2.

North Carolina Plans Road Bond Issue Campaign

The two leading good roads associations of North Carolina, the North Carolina Good Roads Association and the Citizens Highway Association, are planning to get together to work for adequate legislation at the January meeting of the State Legislature that will give the state a definite system of highways and sufficient money with which to construct and maintain it. A systematic speaking campaign will be inaugurated under the joint auspices of these two organizations and prominent legislators have been called upon to assist. The Citizens Highway Association has in mind the drafting of a good roads bill, embodying the views of the association, to be presented to the coming session of the Legislature. The bill, it is understood, will ask for the issuance of bonds in sufficient amount, probably $100,000,000, to establish a state system of highways.

Military Engineers To Attend 22nd Regiment Review

Five former colonels and the New York Post of the Society of American Military Engineers are to be the guests of honor at the military review of the 22nd Engineers to be given at 8:30 p.m., Nov. 15, at the regiment's armory, 168th St. and Fort Washington Ave., New York City.

The 22nd Engineers is the first National Guard engineer unit to become federalized, the completion of its federalization taking place Nov. 5. It is partly in celebration of this event and partly as an honor to the retiring colonel of the regiment that the review is to be held. Col. George D. Snyder is the retiring colonel and will act as reviewing officer, and Col. F. E. Humphreys, a graduate of West Point but who is not now in the regular army, is the 22nd's new commanding officer.

Military Engineers Start Drive To Increase Membership

At a recent meeting of the board of directors of the New York Post, Society of American Military Engineers, the membership committee was enlarged as the first step in an intensive campaign to bring into the organization ex-service men and others interested in the national defense. There are now 111 members in the post, and it is estimated that in New York and vicinity, there are from 800 to 1,000 ex-service engineers eligible to membership.

The new membership committee, which still retains as its chairman the chairman of the old committee—Col. T. C. Clarke—is composed of the following men: Cols. O. B. Perry and E. S. Shaughnessy; Lieut.-Cols. Philander Betts, J. P. Hogan, and Evarts Tracey; Majors J. P. Hallihan, Chandler Davis, E. C. Church, Irving V. A. Huie, W. J. Hammer, A. C. Harper, J. W. Mark, and E. E. Sherwood and Lt. A. D. Fitzgerald.

Low Bids Received in Trial N. Y. Highway Letting

Thirty-eight bids, each of them below the engineer's estimate, were received upon eleven road construction projects in the trial letting held by the New York Highway Commission Oct. 29. Bids were received upon each of the eleven projects advertised. Six bids were received upon each of two projects, five upon each of three others, three on three different projects and two projects each received one bid each. The projects advertised aggregated 32.91 mi. and are situated in eleven different counties of the state.

On one project the low bid was 8 per cent below the engineer's estimate. The average of the low bids on all eleven projects below the engineer's estimate was 4¼ per cent. Another feature in the trial letting was the presence of a comparatively small variation between high and low bids, with three exceptions the high and low bids not varying more than 2 per cent. Among the contractors submitting bids were the names of those now doing extensive work for the state.

It is the intention of the New York Highway Commission, as noted in *Engineering News-Record*, Oct. 28, p. 865, to carry on what winter work it can economically and to let as many contracts as possible during the winter so that construction may start early in the spring of 1921. The trial letting, which has proven quite successful, will doubtless lead the New York Highway Commission to the early letting of many other contracts.

Bill Opposes Publicity for Contracts

Contractors generally are thought to be opposed to Senator Smoot's bill providing for the abolition of the Returns Office in the Department of the Interior. In this office a copy of all contracts made by the War, Navy or Interior Departments is filed in accordance with the statute enacted during the Civil War. The law was aimed at alleged favoritisms in the awarding of contracts during the Civil War. Since that time all contracts made by these departments have been filed in the Returns Office. The law provides that any person may inspect these contracts and that a copy must be furnished for a fee of 5c. per 100 words.

The opposition to the Returns Office is understood to come largely from the Navy Department. Some officials are of the opinion that the disclosures of contracts ought to be discretionary. It is thought to be in the interest of contractors generally, however, that no secrecy be allowed to surround contracts. The Secretary of the Interior has announced his opposition to the bill. He says the existing law should be extended to all government departments. At the same time he suggests that the Returns Office probably should be taken out of his department and made a part of the Treasury Department.

Rivers and Harbors Congress

The annual convention of the National Rivers and Harbors Congress will be held in Washington, Dec. 8, 9 and 10, 1920.

St. Paul Engineers Object to Clause in Registration Bill

The Engineers' Society of St. Paul, at its regular meeting Oct. 11, refused to approve the registration bill as prepared by the Joint Board unless Section 2 is replaced by Section 2 of Engineering Council's bill. The Section 2 objected to states that no no one is prohibited from designing or executing work, provided that his plans and specifications are not signed by the author as "registered" architect, engineer or surveyor.

The history of the proposed Minnesota Registration Law is as follows: Two years ago the local chapter of the American Institute of Architects introduced a bill into the Legislature providing for the registration of architects somewhat along the lines of the present bill. They claimed that the bill was harmless and asked the engineers not to oppose it as no one was excluded from practicing. This bill did not pass.

When the architects joined with the engineers this summer to formulate a joint bill the inclusion of such a clause as Section 2 again came up. The reason given for including it is that, according to legal advice, such is the only way a registration bill for engineers and architects can be passed.

A. R. A. Joint Committee on Automatic Train Control

At the recent meeting in New York of the Joint Committee on Automatic Train Control, which was appointed by President R. H. Aishton, of the American Railway Association, the following officers were appointed: Chairman of the committee, C. E. Denney, vice-president and general manager, New York, Chicago & St. Louis R.R.; vice-chairman for operating division, T. H. Beacom, vice-president and general manager, Chicago, Rock Island & Pacific Ry.; vice-chairman for engineering division, A. M. Burt, assistant to the operating vice-president, Northern Pacific Ry.; vice-chairman for signal division, W. J. Eck, signal and electrical superintendent, Southern Ry., and vice-chairman for mechanical division, J. T. Wallis, chief of motive power, Pennsylvania System.

The duties of the Joint Committee are to confer with the Interstate Commerce Commission, to prescribe rules for tests, and to arrange for actual tests. Under the terms of the Transportation Act the Interstate Commerce Commission has authority to order any carrier, upon two years' notice, to install automatic stops and train control of a design approved by the commission.

Governor's Conference To Consider Housing Problems

Housing problems and the promotion of home ownership will be considered at the State Governor's Conference at Madison, Wis., Dec. 1 to 3. Among the other topics on the program are the Kansas Industrial Relations Court and state incomes and expenses. Miles C. Riley, Madison, Wis., is secretary of the conference.

Cornell Engineers Increase Society Membership

At the meeting of the Cornell Society of Civil Engineers in New York City, Oct. 19, a resolution was passed changing the name of the society to the Cornell Society of Engineers and making eligible for membership not only the civil enginers but also all "persons who have been members of the engineering colleges of Cornell University as students or teachers for a period of one year or longer." This provision will admit to membership all Sibley college men, including the mechanical engineers, electrical engineers and the architects.

The Cornell Society of Civil Engineers had a membership of 1,015, and it is expected that the action taken Oct. 19 will result in forming the largest alumni engineering society in the United States, since those now eligible for membership are three times as great in number as previously.

In 1919, shortly after it was learned that the combination of the engineering colleges of Cornell University was under consideration, the executive committee of the Cornell Society of Civil Engineers began to consider the best way to enlarge the society, and it was decided that action should be taken looking to the admission of all Cornell engineers.

The meeting last week was addressed by Dean-elect Dexter S. Kimball, Cornell University, and by Clifford M. Holland, chief engineer, Bridge and Tunnel Commission of New York and New Jersey.

The following officers were elected for the year 1920-1921: President, Ira W. McConnell; first vice-president, J. Wright Taussig; second vice-president, Prof. Henry N. Ogden; recording secretary, Earl W. Hall; corresponding secretary and treasurer, Carroll R. Harding.

Highway Construction in Illinois Speeded Up

During the five weeks ended Oct. 29, the State of Illinois added to its 1920 highway mileage 77 mi. of federal-aid roads and 30 mi. of state-aid roads, a total of 107 mi. completed for the five-weeks' period. This makes a total of 310 mi. constructed under the supervision of the Division of Highways since Jan. 1, 1920. Illinois still has 158 mi. of uncompleted 1919 and 1920 contracts. All of this mileage is hard surfacing.

Devil's Gate Flood Control Dam Completed in Pasadena

The Devil's Gate Dam, a unit of the Los Angeles County flood control system, was completed in October. It is located on the Arroyo Seco, a flashy winter stream tributary to the Los Angeles River, in the City of Pasadena. The dam has a maximum height of about 120 ft. above bed rock, is arched in plan, has a crest length of 310 ft., with a roadway and two sidewalks across the top. It is built of masonry and has an outlet near the bottom, a tunnel outlet through the mountain and a regulator-spillway. J. W. Regan is flood control engineer. Notes on the dam appeared in *Engineering News-Record*, Feb. 13, 1919, p. 351, and March 6, 1919, p. 315.

Montreal Bridge Plan Considered

A meeting held at Montreal, Nov. 2, under the auspices of the Central Montreal Terminal Co., failed to attract any enthusiastic representation. The chairman, C. N. Armstrong, explained the purpose of the meeting as being to give those interested in a St. Lawrence River bridge project an opportunity to express their opinions. The company, formed in 1890, was prepared to erect a fifteen-span bridge, he stated, the bridge to be 5,000 ft. long and to provide for two railway tracks, two vehicle roadways, and two footways. This structure would reach Papineau Ave. for vehicle and passenger access, the railway level extending to Ontario St. The company has acquired real estate for the project and is expecting to ask for government subsidies. It has claimed to have exclusive right for the construction of a river crossing at Montreal, and considers the present public sentiment in favor of a crossing to entitle it to public support. The principal officers of the company are C. N. Armstrong, president. F. E. Cae, secretary, E. R. Lafleur, chief engineer.

Engineering Council Urges Engineer for Shipping Board

An effort will be made by Engineering Council to secure the nomination of an engineer as a member of the Shipping Board. It is possible that names may be submitted to the President in each of the geographical divisions of the coast. The act provides that these divisions must be recognized in the selection of Shipping Board members. The divisions of the coast usually accepted are: North Atlantic, South Atlantic, Gulf, Pacific, and Great Lakes.

It is believed that the President will withhold his nominations for the Shipping Board until Congress has remedied its oversight in failing to provide for an appropriation for the salaries of the members. A recent publication of a list of names purporting to be those that the President would nominate, was declared to be entirely unauthentic at the White House.

American Road Builders To Hold Annual Meeting

The annual meeting of the American Road Builders' Association is to be held at the Automobile Club, New York City, the afternoon and evening of Nov. 15. Election of officers will be held in the afternoon and, after a dinner at the club, committee reports will be received and informal discussions will be heard on various phases of the road construction situation. A meeting of the executive committee will be held immediately preceding the annual meeting that is scheduled for 3 p.m.

The ballot that has been prepared by the nominating committee follows:

President, M. A. Faherty, chairman, Chicago Board of Local Improvements; vice-president, Northeastern District, J. A. Duchastel, city engineer, Outremont, Canada; vice-president, Southern District, Lieut.-Col. H. L. Bowlby, Bureau of Public Roads; vice-president, Central District, Robert C. Terrell, state engineer, Oklahoma; vice-president, Western District, S. Benson, chairman, Oregon State Highway Commission; secretary, E. L. Powers, editor of *Good Roads*; treasurer, Senator James H. MacDonald, former Connecticut State Highway Commissioner.

The directors proposed are:

Irving W. Patterson, chief engineer, State Board of Public Roads, R. I.; William R. Smith, president, Lane Construction Corp., Meriden, Conn.; John Swan, director of public works, Pittsburgh; J. H. Cranford, president, Cranford Paving Co., Washington; W. G. Sucro, Baltimore County Roads Engineer, Md.; W. A. McClean, Deputy Minister of Highways, Province of Ont., Canada; and A. B. Fletcher, state highway engineer, Cal.

Rail Guarantee $656,000,000

According to figures made public by the Interstate Commerce Commission, Nov. 2, $656,000,000 will have to be provided by the Federal Government to pay the railroads the guaranteed return under private operation for the period March 1 to Sept. 1, 1920. The railroads suffered an actual deficit of $206,000,000 during this period and the Treasury must pay them $450,000,000, the amount of the guarantee provided in the Transportation Act.

Montreal Street Tunnel Planned

A proposal for a street tunnel under the Champ de Mars and Jacques Cartier Square has been made to the Chambre de Commerce by Joseph Girard. A committee of the Chambre did not endorse the project, but recommended that it be forwarded to the city's administrative commission. The plan is for a tunnel from Craig St. to the harbor front, to enable up and down traffic to avoid the congested territory between.

Major Jenny Speaks at Allied Machinery Smoker

Major J. A. Jenny, who accompanied Gen. Pershing to France when the vanguard of the American Expeditionary Forces sailed early in 1917, was the principal speaker at a smoker given at the Allied Machinery Center, New York City, Oct. 29. He discussed port construction, storage depots and construction and maintenance of light railways in the forward areas.

Civil Service Examinations United States

For the Civil Service examinations listed below apply to the Municipal Civil Service Commission of the City of New York, Room 1400, Municipal Building, New York, N. Y.

Assistant Engineer, Grade C. Bureau of Buildings, $2,160 to $2,760 a year. Applications received until Nov. 17.

Junior Draughtesman, Grade B. Salary $1,560 to $2,160 a year.

For the United States civil service examination listed below apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the Civil Service Commission.

Senior Engineer, Grade 2, $2,100 to $2,700 a year.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN ROAD BUILDERS ASSOCIATION, New York City, Nov. 15, 1920.

FEDERATED AMERICAN ENGINEERING SOCIETIES, New York; Washington, D. C., Nov. 18-19.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. 19, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

The American Society for Steel Treating announces that a chapter has been formed in Syracuse, including in its membership some of the most prominent men of the local steel industry. Its officials include the following, the first two named being president and secretary: Howard J. Stagg, Halcomb Steel Co.; W. F. McNully, New Process Gear Corporation; F. C. Raab, Brown-Lipe-Chapin Co.; L. M. Senner, H. H. Franklin Mfg. Co.; R. C. Gebert, Hammond Steel Co.; P. A. Hopkins, Penn Spring Works; E. D. Newkirk, Onondaga Steel Co.; O. L. Van Valkenburg, Crucible Steel Co.

The Colorado Society of Civil Engineers, at its monthly meeting Oct. 28, passed resolutions recommending the construction of the three proposed tunnels, passage of the educational amendment and the issuance of bonds to be used in the construction of state highways.

The Oklahoma Society of Engineers at the annual meeting held in Tulsa, Oct. 26-27, by previous arrangement resolved itself into the State Engineering Council. All engineering organiza-

tions in the state were invited to send committees to the meeting to consider jointly matters of legislation and to effect a permanent organization. The engineers' licensing bill and a salary schedule for highway engineers in the state were agreed upon. A bill to strengthen the special assessment paving law was referred to counsel. The engineers recommended the construction of an Engineering Building at the State University to cost $500,000 and recommended the strengthening of the Engineering Department of the State Board of Health. The officers elected for the coming year were: President, George J. Stein, Miami, Okla.; vice-presidents, V. V. Long, Oklahoma City, B. E. Clark, McAlester, and B. F. Lewis, Enid; secretary-treasurer, Donald Witten, Tulsa.

The San Francisco Engineer's Club, at its meeting Oct. 29, elected the following officers: President, J. E. Woodbridge; secretary, C. H. Snyder.

The Pittsburgh Chapter, Am. Soc. C. E. held its annual meeting Oct. 25. Harlan Bartholomew discussed "Zoning as Applied to City Planning." The following officers were elected: President, N. S. Sprague; vice-president, Paul L. Wolfel; secretary and treasurer, Nathan Schein.

The Engineering Society of Buffalo announces the following meetings: Nov. 16, American Chemical and Electrochemical Societies, joint meeting at Niagara Falls, N. Y.; Nov. 23, American Institute of Architects—Oswald Stein will give an illustrated talk on the "Manufacture and Possibilities of Terra Cotta"; Nov. 30, Society of Automotive Engineers.

PERSONAL NOTES

MAJOR H. F. CAMERON, recently commissioned in the Corps of Engineers, U. S. A., has been assigned to duty as assistant to the District Engineer on the construction of the Wilson Dam at Florence, Ala. During the World War he served with rank of lieutenant colonel, Engineers, U. S. A., as chief of the Machinery and Engineering Materials Division, Director of Purchase and Storage, Quartermaster Corps at Washington. Major Cameron's previous experience included a number of years' service in the Philippines for the J. G. White Co. and on Government waterworks and highway construction.

A. R. MANN, formerly president Western Canada Shipbuilders, Ltd., has been elected president of the Northern Construction Co., Winnipeg.

ALFRED M. BARRETT, deputy commissioner, Public Service Commission, First District, New York, and previously superintendent of highways, Borough of Queens, has been appointed Public Service Commissioner for this district to succeed Lewis Nixon, resigned.

H. N. ANDREWS, recently with the engineering department, Youngstown Steel Co., Youngstown, Ohio, has accepted a position with the Wheeling Steel Corporation, Wheeling, W. Va., in its engineering department.

A. L. DIERSTEIN, recently connected with the U. S. Engineer Office, Washington, D. C., has accepted a position with Yeager & Sons, contractors, as engineer in charge of construction of a concrete highway bridge at Danville, Ill.

DAVID F. STOCKBRIDGE, formerly with the Koppers Co., Pittsburgh, Pa., is now chief engineer of The Briggs Company, Lansing, Mich., dealers in building material.

M. R. THORNE, recently general superintendent of the Arthur McMullen Co., New York City, has taken a position with the Atmospheric Nitrogen Corporation to supervise the construction of its plant at Syracuse, N. Y.

J. WALTER ATLEE, recently with the Virginia Railway Co., has accepted a position as office engineer with the C. H. Mead Coal Co., Buckley, W. Va.

NEELY J. CROMER, civil engineer, has accepted a position with the South Carolina State Highway Department at Lanes, S. C.

GEORGE LAUTZ, recently chief engineer of District 1 of the U. S. Forest Service, has been appointed assistant to T. W. Norcross, chief engineer of the U. S. Forest Service in Washington, D. C.

W. PAXTON, formerly with the Goodyear Tire & Rubber Co., Akron, Ohio, has been appointed consulting engineer for the city of Akron in connection with the handling of city garbage and street cleaning.

OTTO S. HESS, district engineer of the Michigan State Highway Commission, has been appointed managing engineer, Kent County Road Commission.

HENRY EXALL ELROD, formerly valuation engineer, Houston, Tex., has been appointed valuation engineer by the city of Dallas to investigate and report concerning the properties of the Dallas Telephone Company.

MANLEY OSGOOD, formerly city engineer of Ann Arbor, Mich., has accepted a position as manager of the Ann Arbor Asphalt Co.

W. G. CHASE, consulting engineer, Winnipeg, and chief engineer of the Winnipeg Aqueduct, has been appointed consulting engineer to the Saskatchewan Water Commission.

H. E. ECKLES, civil engineer, formerly connected with the Board of Local Improvements, Chicago, has accepted a position as assistant engineer on electrification development connected with the depot and terminal electrification project of the Illinois Central R.R., Chicago.

EUGENE H. PADDOCK, recently assistant sanitary engineer in the U. S. Public Health Service, has accepted a position as resident engineer with the Tayford Company, Inc., Lee, Mass., on a hydro-electric development project.

J. R. SHERMAN, recently employed by the Braden Copper Co. on construction work in Chile, has been appointed engineer for the Kittitas Reclamation District in Washington.

MAJOR GEORGE A. LEWIS of Auburn, N. Y., has been named chief engineer and superintendent of the Auburn Water Board to succeed L. B. Cleveland, resigned.

A. E. FOREMAN has resigned as chief engineer, Department of Public Works, Victoria, B. C., Can., to enter private practice.

JOHN T. SCULLY has opened an office in Cambridge, Mass. In addition to engineering construction he will engage in real estate development by selecting sites best adapted to his clients' requirements and giving the benefit of expert service in the construction of his plant.

F. L. FELLOWS, city engineer, Vancouver, has been appointed consulting engineer to the Saskatchewan Water Commission.

T. W. FATHERSON, engineer maintenance of way of the Chicago Great Western R.R., with headquarters at Des Moines, Iowa, has been appointed superintendent of the Western division with headquarters at Clarion, Iowa.

OBITUARY

PERCY B. TAYLOR, consulting structural engineer, died Oct. 21 in Newark, N. J. He was born in Manchester, England, in 1865. He came to this country in 1873 and was connected with Cyrus Currier & Sons and the Taylor-Martin Co., of which he was the head. In 1897 he entered private practice as a consulting engineer in factory construction and affiliated branches of engineering. He designed many industrial buildings for concerns in Newark, including the United Color and Pigment Co., Heller & Merz, Amalgamated Dyestuffs Co., and the American Oil & Supply Co.

DANIEL A. CURTIN, civil engineer, died Nov. 4 in New York. He was for many years employed by the City of New York and previously was chief engineer for the Park Department of Brooklyn.

JOHN B. BENTON, who prior to his retirement from civil engineering work was president of the Benton Manufacturing Co., died Nov. 5 in Union Springs, N. Y. He was 85 years old. He had served as division engineer on the construction of the Erie Canal.